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VOL. CXXXVIII.—No. 3600] LONDON: FRIDAY EVENING, DECEMBER 26, 1924 [PRICE ONE SHILLING IN IRELAND FOR 1s. 2d.

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E.1, REQUIRES :—
SOLID DRAWN TUBULAR STEEL POLES.
Tenders due on the 13th January, 1925.
Tender forms obtainable from above. 7835

The Queen's University of Belfast.
JUNIOR ASSISTANT IN ENGINEERING.
APPLICATIONS are INVITED for the POST of JUNIOR ASSISTANT in the Department of Civil Engineering. Salary £300 per annum, duties to commence early in January, 1925.
Further particulars may be obtained from the undersigned, by whom applications with testimonials must be received on or before Saturday, January 10th, 1925.
F. H. HUMMEL,
7804 Professor of Engineering.

City of Birmingham Water Department.
BARTLEY RESERVOIR.
The Water Committee invite TENDERS for the CONSTRUCTION of the BARTLEY RESERVOIR on a site adjoining their existing Reservoir at Frankley, near Birmingham.
The reservoir will be a storage reservoir with a content of over 500 million gallons. The works will comprise the following :—
An earthen embankment with shallow cut-off trench and reinforced concrete core wall, valve tower with reinforced concrete footbridge, outlet culvert and pressure tunnel, inlet culvert and channel, inlet gauge chamber and recorder house, reservoir lining consisting of pre-cast concrete slabs, reinforced concrete in situ, pitching and beaching, road diversions and other subsidiary works.
Conditions of contract (which include the Corporation's usual fair wages and conditions of labour clauses), specifications and forms of Tender may be obtained on and after December 20th, 1924, from the Secretary, Water Department, Council House, Birmingham.
All applications for Tender forms must be accompanied by a deposit of £10, which will be returned to the applicant on receipt of a bona fide Tender.
The drawings may be seen at the Water Department Offices (Secretary's Office entrance), Council House, between the hours of 10 a.m. and 1 p.m. on December 29th, 1924, January 2nd, 6th, 9th, 13th, 16th, and 20th, 1925. An Assistant Engineer will be in attendance on these dates between 11 a.m. and 1 p.m. After 2 p.m. he will attend at the reservoir site to afford any further information to tenderers.
Tenderers desiring to have copies of any of the drawings, to assist them in preparing their Tenders, will be supplied with such copies upon payment to the Secretary of 2s. 6d. per copy, which amount will not be returned. All drawings so supplied must be returned to the Secretary under separate cover at the same time as the Tender is submitted.
Tenders must be delivered under seal, addressed to "The Secretary, Water Department, Council House, Birmingham," endorsed "Tender for Bartley Reservoir, Contract No. 12," not later than Noon on 28th January, 1925.
The Committee do not bind themselves to accept the lowest or any Tender.
J. H. BROADLEY,
Secretary.
Water Department, Council House,
Edmund-street, Birmingham,
19th December, 1924. 7830

Urban District Council of Fleet (Hants).
EXTENSION OF EXISTING SEWERAGE AND SEWAGE DISPOSAL WORKS FOR FLEET.
UNEMPLOYMENT RELIEF WORKS.
GENERAL CONTRACT.
The Urban District Council of Fleet invite TENDERS from responsible and experienced contractors for the CONSTRUCTION of those WORKS, which comprise several miles of Cast Iron and Stoneware Sewers, Brick, Concrete and Cast Iron Manholes, Flushing Tanks, Ventilating Shafts and Columns, Cast Iron Rising Main, Air Mains, and additions to the Sewage Disposal Works, and other incidental work.
A copy of the specification and form of Tender, and bills of quantities may be obtained, and the drawings inspected, on and after a date to be communicated to persons tendering, on application, in writing, to Major T. J. Moss-Flower, Civil Engineer, 28, Victoria-street, Westminster, S.W., and Carlton Chambers, Bristol, at his Bristol office, on deposit of a £10 Bank of England Note, which will be refunded, provided a bona fide Tender be received, and is not withdrawn before the sealing by the Council of one of the Tenders, and provided also that all documents supplied be returned to the Engineer.
The Contractor carrying out the work will be required to comply with the regulations of the Unemployment Grants Committee with regard to the employment of labour during the performance of the contract, and the work must be actively commenced by the 12th January, 1925.
Sealed Tenders, endorsed "Tender for Fleet Sewerage and Sewage Disposal Works, General Contract," are to be delivered at the Council Offices, not later than Noon on the 7th January, 1925.
The lowest or any Tender will not necessarily be accepted.
Dated this 15th day of December, 1924.
(By Order),
ERNEST NASH,
Solicitor and Clerk to the Council.
Council Offices,
Fleet (Hants). 7785

FLEET (HANTS).
Urban District Council of Fleet (Hants).
NEW SEWERAGE EXTENSION WORKS FOR FLEET, HANTS.
UNEMPLOYMENT RELIEF WORKS.
TO CAST IRON PIPE FOUNDERS.
The Urban District Council of Fleet (Hants) invite TENDERS for the SUPPLY and DELIVERY at Fleet of about 230 TONS, more or less, of CAST IRON PIPES, varying in size from 3in. to 24in. internal diameter, also a number of BENDS, TAPER JUNCTIONS and other SPECIALS.
A copy of the specification and form of Tender may be obtained on application, in writing, to Major T. J. Moss-Flower, Civil Engineer, 28, Victoria-street, Westminster, S.W., and Carlton Chambers, Bristol, at his Bristol Office, on and after the 21st December, 1924, on payment of the sum of Three Guineas, which will be returned, provided a bona fide Tender be received and is not withdrawn before the acceptance by the Council of one of the Tenders.
Sealed Tenders, endorsed "Tender for Cast Iron Pipes," are to be delivered at any office at Fleet by Twelve Noon on 1st January, 1925.
The lowest or any Tender will not necessarily be accepted.
Dated this 18th day of December, 1924.
ERNEST NASH,
Clerk to the Council.
Council Offices, Fleet, Hants. 7833

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

New Water Supply for the Jharia Coalfield.

The Early History of the Cylinder Boring Machine—No. II.

The Work of W. & R. E. Froude—No. III.

Individualism in Locomotive Design.

The Operation of Centrifugal Pumps.

100 Years of British Railways—No. XXVI.

Fibre in Metals.

A Fishery Patrol Boat.

New Sewage Disposal Plant.

PUBLIC NOTICES

Rural District Council of Axminster.
COUNTY OF DEVON.
AXMOUTH ROAD IMPROVEMENT.
The Rural District Council of Axminster are prepared to receive TENDERS for the IMPROVEMENT of the existing ROAD between Tanyard Cross and Axmouth Bridge.
Particulars and specification may be obtained at the offices of the Consulting Engineers, Messrs. Howard Humphreys and Sons, at 28, Victoria-street, Westminster, on and from Monday, the 29th of December, 1924, until Saturday, the 10th of January, 1925, between the hours of 10 a.m. and 4 p.m., upon the payment of a deposit of Three Guineas, which deposit will be returned upon receipt of a bona fide Tender which is not subsequently withdrawn by the contractor.
The successful tenderer will be required to execute a contract deed, the draft of which may be seen at the offices of the Consulting Engineers when the drawings are inspected.
Tenders must be on the official form, each Tender in a sealed envelope marked "Tender for the Axmouth Road Improvement." Tenders must be accompanied by the general conditions and specification as issued by the Consulting Engineers.
Each Tender must be signed in the handwriting of the tenderer or his authorised agent.
The Council does not bind itself to accept the lowest or any Tender.
Tenders must reach the undersigned by 9 a.m. on Monday, January 26th, 1925.
Given under my hand the 19th day of December, 1924.
CECIL FORWARD,
Clerk to the Rural District Council of Axminster.
Devon. 7831

Taf Fechan Water Supply Board.
PIPE LAYING.—CONTRACT No. 3.
The Taf Fechan Water Supply Board are prepared to receive TENDERS from competent persons for the LAYING of about 21 Miles of STEEL and CAST IRON PIPES of 37in. and smaller diameters, together with ancillary works in the counties of Brecknock and Glamorgan, and for the CONSTRUCTION of a BREAK PRESSURE TANK.
Drawings may be seen, and instructions to tenderers and specifications and bill of quantities obtained, on and after the 23nd December, 1924, at the office of Sir Alex. Binnie, Son and Deacon, 20, Buckinghamgate, Westminster, S.W., on payment of a cheque for £5, made out to the Taf Fechan Water Supply Board, which amount will be returned on receipt of a bona fide Tender.
Sealed Tenders, endorsed "Tender for Pipelaying," should be delivered at my office at or before Noon on Thursday, the Fifteenth day of January, 1925.
The Tenders so sent in are to be accompanied by the bill of quantities fully priced out, and the Board do not undertake to accept the lowest or any Tender, or to defray any expenses in connection with tendering, and will only consider such Tenders as are sent in by contractors who have previously executed works of a similar kind and magnitude.
J. COLENSO JONES,
Clerk to the Board.
Board's Offices,
101, High-street,
Merthyr Tydfil. 7760

SITUATIONS OPEN

WANTED IMMEDIATELY, Competent ENGINEER to Take Sole Charge of Department in large and old-established Engineering Works, handling sluice gates, valves, &c., for Hydro-electric and Irrigation Plants, &c. Wide outside experience and knowledge of Design and Estimating essential. Only first-class man will be considered, and the successful applicant must be prepared to take over duties early in January.—Address, stating age, qualifications and salary required, &c., 7839, The Engineer Office. 7839 A

PUBLIC NOTICES

Burma Railways.
BRIDGE ENGINEER.
The Directors are prepared to receive APPLICATIONS from properly qualified candidates for APPOINTMENT as ASSISTANT ENGINEER (Bridge Engineer) for service on the Company's Railway in Burma.
Candidates should be between 25 and 30 years of age, active and of good physique. They must possess a thorough knowledge of girder design and manufacture, and have had a good theoretical training in engineering knowledge at a recognised Engineering College. Particulars should be given as to whether applicants have had any outside experience of the erection or renewal of bridges either at site or in a bridge builder's yard.
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The selected candidate will be required to pass a strict medical examination by the Company's Consulting Physician before appointment.
Applications (by letter only), giving particulars of applicants' general and technical education and training, and showing in chronological order (with dates) where and how they have been employed from time to time, should be addressed to the undersigned, to be received not later than the 12th January, 1925.
MANAGING DIRECTOR.
199, Gresham House,
Old Broad-street, London, E.C. 2. 7822

SITUATIONS OPEN, Page 2.

WANTED, ESTIMATE and QUOTATIONS CLERK (first class), used to Wrought Iron Tube Trade.—Apply, stating experience, age, and salary required, to P.O., Box 24, Walsall. 7827 A

CAPABLE ENGINEER REQUIRED, to Run a Commercial Motor Vehicle Department in large provincial town for an established firm; must be young, energetic, a good organiser, and possess good experience.—Address, with full particulars and copy of references, 7837, The Engineer Office. 7837 A

ELECTRIC TRACTION ENGINEER.—WANTED by large Manufacturing Firm, ENGINEER with Specialised Knowledge of Design and Manufacture of Electric Railway Motors; must have ability and practical experience in Determination of Motor Requirements for specific electric traction projects. Good remuneration and excellent prospects offered. Only ambitious and progressive men with practical experience need apply. State full particulars, salary required and earliest date commence.—Address, 7842, The Engineer Office. 7842 A

ESTIMATOR REQUIRED. Capable of Making Estimates from Project Drawings for Mechanical Handling Plants for Coal and other materials; only men with good experience and proved abilities need apply. State age, experience and salary.—Address, 7840, The Engineer Office. 7840 A

THE NATIONAL OMNIBUS and TRANSPORT COMPANY, Limited, REQUIRE an ASSISTANT WORKS MANAGER, age about 30/35; Manufacturing Experience and good knowledge of Bodywork, Running Repairs and Maintenance of Rolling Stock essential.—Applications, giving full particulars of experience and salary required, to be addressed to THE SECRETARY, 206, Brompton-road, S.W. 3. Envelopes to be marked "AWM." 7770 A

PUBLIC NOTICES

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
Notice is Hereby Given that WILHELM BORCHERS, Dr.-Ing. Ph.D., 15, Ludwigsallee, Aachen, Germany, a citizen of the German Republic, and ROBERT WICKERSHAM STIMSON, 17, West 56th Street, New York, United States of America, a citizen of the United States of America, SEEK LEAVE to AMEND the SPECIFICATION for LETTERS PATENT No. 223,617, entitled "Process for Refining Crude Chromium Alloys."
Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents) issued on the 17th December, 1924.
Any person, or persons, may give notice of opposition to the amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.
W. TEMPLE FRANKS,
7843 Comptroller-General.

SITUATIONS OPEN (continued)

ASSISTANT ENGINEERS AND DRAUGHTSMEN. —WANTED AT ONCE, ONE or TWO ASSISTANT ENGINEERS, experienced in Building Construction, Dock and Railway Work, as residents on large Factory Construction Schemes in England. Also ONE or TWO experienced BUILDING DRAUGHTSMEN used to Steel Construction and Heavy Engineering Work, REQUIRED in London.—Write, stating age, experience and salary required, to A. E. D., at Hornsettle's, 60, Cheapside, E.C. 2. P9915 A

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WANTED, DRAUGHTSMAN, with Good Experience of Hydraulic Work, particularly of Cranes and Hoists. Applications must state experience, salary required, and age, which should be between 30 and 40 years.—Address, 7829, The Engineer Office. 7829 A

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RESIDENT ENGINEER or CONTRACTORS' AGENT. POSITION WANTED as; roads, bridges, docks, railways.—Address, P9880, The Engineer Office. P9880 B

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MISCELLANEOUS

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THE PROPRIETOR of BRITISH PATENT No. 164,274, dated September 22, 1920, relating to "Improvements in Apparatus for Sterilising Liquids," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—Inquiries to B. SINGER, Steger Building, Chicago, Illinois. 7836 E

THE PROPRIETOR of BRITISH PATENT No. 179,575, dated December 6th, 1920, relating to "Improvements in Ship's Course Indicator and Recorder," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—Inquiries to be addressed to B. SINGER, Steger Building, Chicago, Ill. 7740 E

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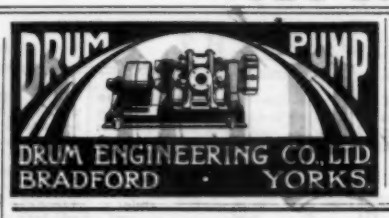
For continuation of Small Advertisements see page 92.



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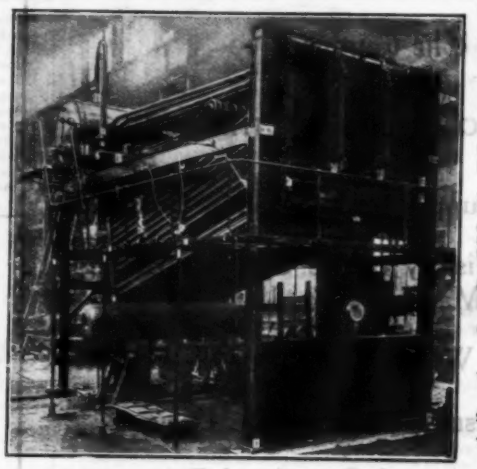

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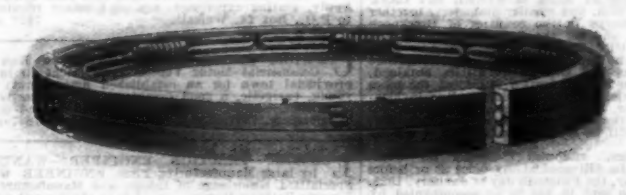

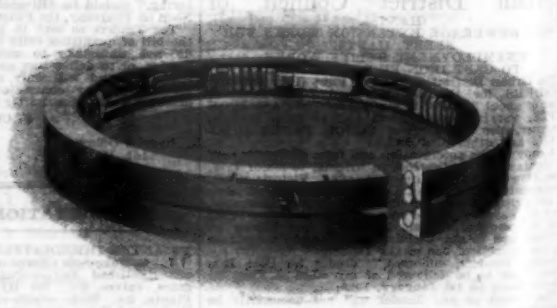

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The London Traffic Problem.

The newly constituted London and Home Counties Traffic Advisory Committee is already considering several schemes of great magnitude, aiming at the relief of traffic congestion in the London area. Sir Henry Maybury, of the Ministry of Transport and chairman of the Committee, has stated that among such schemes are the enumeration of congested routes, consideration of the question of one-way traffic, the separation of fast and slow-moving traffic, and the construction, at a cost of £3,500,000, of a great new roadway to the East London docks. At present, congestion in the dock area is undoubtedly slowing down London traffic as a whole. At certain points a road width of only 21ft. is available, and is intersected by railway crossings and swing bridges. It is not uncommon for queues of vehicles three-quarters of a mile long to be held up for 45 min. at a time. From an engineering point of view, the most interesting scheme referred to by Sir Henry is the project for the construction of a road tunnel 2¼ miles long under the Thames, from a point east of Dartford, on the south side of the river, to a point on the north bank, at which it would connect with the new by-pass road at Purfleet. The scheme proposed some years ago and recently revived for the construction of a tunnel between Gravesend and Tilbury has, it seems, been abandoned, because it has been found that the tunnel would have to be driven at such a great depth as to make the project impossible from the engineering point of view. The Dartford–Purfleet tunnel, Sir Henry holds, would deflect a large volume of north and south traffic from the London area. It would have a carriageway 20ft. in width, would involve an expenditure of about £3,000,000, and would take about three years to complete.

The Shannon Hydro-electric Scheme.

The Irish Free State Minister for Industry on Friday of last week submitted to the Dail the report prepared by the five European experts called in to report upon the scheme for harnessing the river Shannon, prepared by the Berlin firm of Siemens-Schuckert. The experts came to the conclusion that the scheme would enable the whole of the present electrical requirements of the Free State to be obtained from the Shannon, and estimated that energy from the river could be delivered in Dublin at a cost of 0.53d. per unit. Partial development, involving an expenditure of £5,000,000, was recommended as a beginning, the full scheme, costing £7,000,000, to be completed subsequently. The experts also suggested the development of a scheme on the river Liffey, at a later date, as an adjunct to the Shannon scheme. The report was approved. It would appear that the schemes contemplate obtaining from the Shannon an average of about 17,000 kilowatts.

Mr. D. B. Morison Retires.

With the end of the year, Mr. D. B. Morison will terminate his long association with Richardsons, Westgarth and Co., Limited, the well-known North-East Coast firm of marine engineers. Mr. Morison was manager of the Hartlepool Engine Works of Thomas Richardson and Sons in 1900, the year in which they were merged in the present establishment, and was appointed joint managing director of the new company. In 1912 he was made sole managing director, and in 1918 was, in addition, appointed to the chairmanship of the company. These joint responsibilities are now to be divided. Mr. Tom Westgarth, who has been a director of the company since its formation, will assume the office of chairman, and Mr. George Clark, who has been a director since 1917, will act as managing director. Mr. L. D. Wingate is to take up the duties of general manager.

Steel Houses and Labour.

The labour view regarding the erection of steel houses of the Weir type has now been closely defined by Mr. R. Coppock, the secretary of the National Federation of Building Trade Operatives. As a national policy, Mr. Coppock has laid down the law that in the erection of houses which require building trade operations, building trade practices as to hours, wages and general conditions are to obtain. Last October, he states, Messrs. Weir were informed of the situation that would arise "if they attempted to pursue a practice of employing labour contrary to the conditions existing in the building industry." The argument seems to be that the Weir and similar steel houses are not engineering productions, but essentially the same as ordinary houses. Mr. Coppock holds that they are not even innovations, and considers their description as steel houses as being untruthful. No new technique, he argues, is required in their erection, and the fact that they are to be standardised does not necessarily mean that craftsmanship will be eliminated. In spite of these views, Mr. Coppock tells us that building trade operatives are making no effort to prevent the erection of any alternative type of house, being concerned merely with demanding that established building trade practices and conditions shall be observed in connection with their construction. As the observing of these practices and conditions will almost inevitably destroy nine-tenths of the economic advantages of the steel house, and, moreover, will deprive many unskilled workers at present unemployed of a chance of earning a livelihood, it is difficult to believe in Mr. Coppock's sincerity.

Wireless and Employment.

That the growth of popular interest in wireless telephony has created something of a new industry, not only for large and established firms of electrical engineers, but also for small manufacturers producing components and assembled parts, is obvious to anyone in any town. Up to the present, considerable assistance in the creation of this new industry has been derived from the condition imposed by the Postmaster-General's licences that no one authorised to establish a wireless receiving station shall knowingly use apparatus or equipment of foreign origin. With the end of this year that condition will be withdrawn, and in the opinion of some the industry in this country will, as a consequence, suffer severely. Last Friday, it was suggested by a Member of Parliament that in Birmingham alone the continuous employment of nearly a thousand people would be imperilled by the withdrawal of the restriction on the use of foreign material. The Assistant Postmaster-General, in reply, stated that the decision to revoke the regulation was based on a recommendation of the Broadcasting Committee of 1923, and was covered by an agreement with the British Broadcasting Company. He was satisfied that there was no grave danger of creating unemployment by opening the door freely to foreign wireless goods. If trouble arose, the wireless industry, he said, would have the same means of securing redress as any other, a reference, we presume, to the new Safeguarding of Industries Bill.

A New Type of Windmill.

The Department of Agricultural Engineering at Oxford University is to be congratulated on its initiative in securing the first rights to make a complete test of the efficiency and usefulness of a new type of windmill which has been invented in Germany. The windmill differs from the ordinary type, and was developed by Major Bilau at the Göttingen Aerodynamical Institute. From the preliminary reports which have reached us we learn that four blades are used in the form of a propeller, and that each of these blades has been designed on scientific aerodynamical principles. A form of regulator is used which permits the apparatus to drive a dynamo for generating current. The machine is said to be easily transportable, and is mounted on a 10in. concrete column, about 40ft. in height, which is stayed with wire ropes. A propeller, 25ft. in diameter, is employed, and an output of about 10 brake horse-power is obtained. Such machines may, we learn, be designed for outputs up to approximately 35 brake horse-power. The invention will be developed in the British Empire by an English company.

British Shipbuilding and Trade Facilities.

It appears that the Government has now decided to accord to shipbuilding the importance it once enjoyed in respect of guarantees made under the Trade Facilities Act. This subject was referred to by the Prime Minister last week. He stated that shipbuilding would once more have the right of access to the Trade Facilities Committee. Although much has been already done in this matter, it will prove very helpful to the industry if by such means foreign owners can be induced to place further orders in British yards. British owners might, moreover, be assisted to quicken the renewal of their fleets, so that full advantage of the revival of trade may be obtained. Any note of hope which may hereby be lent to the future prospect of the shipbuilding industry must be tempered by the fact that the Boilermakers' Society recently applied for a 10s. per week increase, while the Plumbers' Society on Saturday last lodged a claim with the Shipbuilding Employers' Federation for an increase of £1 per week in the wages of all members employed in shipyards. The Federation of Engineering and Shipbuilding Trades is to seek an early conference with the employers to discuss the wages question. It is probable that such a conference will be arranged for about the middle of January.

A Standard Periodicity.

New efforts are apparently being made to standardise the periodicity of electricity supplies in this country. Plans are being considered by the Government for a combined effort by the State, the municipalities and private enterprise to bring about a standard periodicity of 50 cycles per second, but in view of the fact that a considerable amount of current is already generated at 25 cycles and at various other odd periodicities, we do not quite see how the difficulties associated with a complete change over to 50 cycles per second can be overcome. Possibly, however, the object is to standardise the periodicity of all future supplies, which, of course, is very desirable. From the point of view of linking up stations, a standard periodicity is obviously essential, for otherwise frequency changers, which cost a considerable amount of money and introduce losses, must be interposed between the systems that are interconnected. Moreover, a standard periodicity would be a great advantage to the electrical manufacturers, who at present have to design motors, transformers, &c., to meet a good many conditions. A universal 50-cycle supply would undoubtedly eliminate a great deal of complication and trouble, and should have a marked influence on the cost of electricity. If the pioneer electrical engineers had realised the importance of a standard periodicity, many of the present difficulties in the electrical industry would have been avoided.

The Teletype System of Communication.

In a paper read last Thursday before the Institution of Electrical Engineers, Mr. Donald Murray dealt with the teletype system of communication. The teletype, as many are no doubt aware, is a simple telegraph machine which types and transmits telegrams. Once the system has been installed, Mr. Murray explained, a business man in London will be able to book a trunk call to a subscriber in Dundee or New York or Rome, in the same way as a trunk telephone call is obtained to-day. When the calling and answering subscribers are connected, the typist in the calling office will type a message which will be reproduced simultaneously on the typewriter at the other end, and an answer will be sent in the same manner, and with equal ease. But it is not absolutely essential for a subscriber to answer a call. Messages can, in fact, be sent all night, when the receiving office is closed, and when the staff arrives next morning the correspondence will be ready for inspection. The system has already been installed in several parts of America, and the latest experiments have, it is said, proved so successful that at least six models of the teletype are about to be placed on the market. The system has also been tested in London. Although Mr. Murray made some very broad claims for his scheme, the discussion on his paper was not by any means a hostile one.

Institution of Mechanical Engineers' Dinner.

The annual dinner of the Institution of Mechanical Engineers, held in London on Thursday of last week, was graced by the presence of his Royal Highness the Prince of Wales as the guest of honour. The Prince is an honorary life member of the Institution. In the course of an admirable speech, in which he proposed the toast of "The Institution," he revealed the fact that his presence there that night was the result of an invitation extended to him this year by Mr. Patchell at a chance meeting in Detroit. Much amusement was created by his declaration that on the occasion of that meeting Mr. Patchell was neither among the workshops or blast-furnaces, nor assembling the entrails of a Ford car or testing a sample of iron ore but enjoying a cup of tea in a comfortable Detroit club. He dwelt upon the necessity for the existence of a body such as the Institution of Mechanical Engineers, which could exercise scientific control over the nation's mechanical activities. The maintenance of Great Britain's record and traditions in engineering rested, he said, largely in the hands of the Institution and similar bodies. Its activities, avoiding the creation of a state of paralysing chaos, set up a definite standard of responsibility in the profession, stimulated the nation's store of talent and enabled each successive generation to inherit the practical results achieved by the last. The Marquis of Salisbury, replying to the toast of "His Majesty's Ministers," twitted the Earl of Derby, another of the guests, with the fact that his ancestors had opposed tooth and nail the construction of the Liverpool and Manchester Railway. Lord Derby, in responding for the visitors, said that it was unlikely that a stained glass window would be set up in Westminster Abbey in memory of his activities in the field of engineering, but claimed indulgence for his forebears' opposition by virtue of the close attention which he himself had paid to the development of certain four-stroke one-horse power machines.

The Ferrantians' Re-union.

Nearly fifty old Ferranti men were present at the third re-union held at the Hotel Cecil, London, on December 17th. The chair was occupied by Mr. H. W. Kolle, and Dr. S. Z. de Ferranti was the guest of the evening. Responding to the toast of his health, Dr. Ferranti said that work was its own reward, and in that respect he felt fully recompensed by seeing his early ideas adopted and put into commercial practice. In this connection he instanced the employment of re-superheating and progressive feed heating. He was still as impressed as ever with the illimitable nature of the electrical field; while much had been done much more yet remained to be done. He visualised a new era in transport with the coming of the right type of storage battery for motor cars, and foresaw a great future for electricity on railways.

The Early History of the Cylinder Boring Machine.*

By E. A. FORWARD, A.R.C.S., M.I. Mech. E.

(*Concluded from page 687*)

THE earliest instance we are able to trace of the screw feed in a boring mill is on a Swedish gun mill, illustrated in the "Memoirs" of the Stockholm Academy for 1782. This was a mill of the kind patented by Wilkinson in 1774, that is, one in which the gun rotates while the non-rotating boring tool is fed up to it. The usual feed mechanism on those mills was either levers or rack and pinion, but in this example a screw about half as long as the gun bore was used. The screw was prevented from rotating and passed through a nut turned by a hand wheel, its point bearing against the back end of the boring tool. On reaching the end of its travel, the screw was withdrawn and a distance piece inserted between it and the tool.

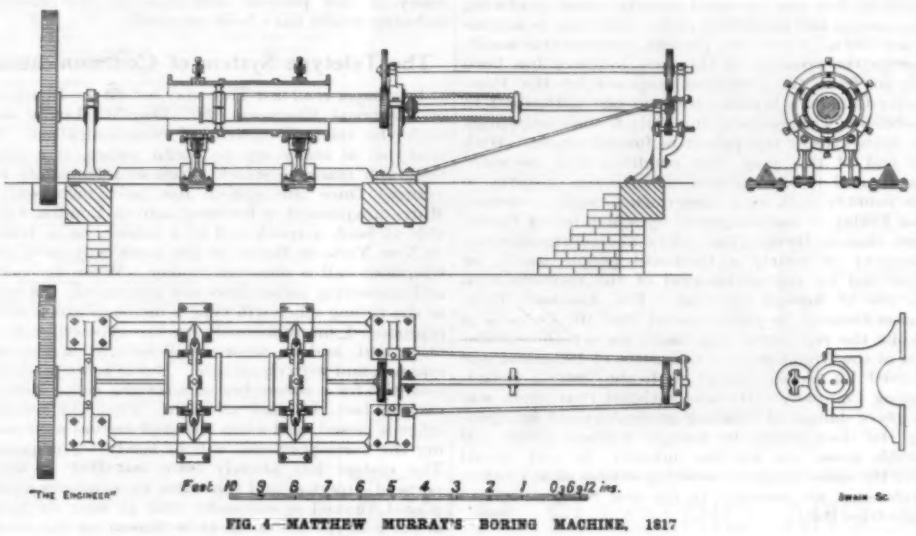

FIG. 4—MATTHEW MURRAY'S BORING MACHINE, 1817

Amongst the tools at Soho in 1895 there was a horizontal screw feed boring bar, 11.875in. diameter and 14ft. 4in. long, said to have been made in Murdock's time. This had a hand-cut screw passing through a nut fixed to the cutter head, but it did not pass down the centre of the bar, but lay in a groove close to the surface. The screw was rotated by an epicyclic train from a fixed pinion mounted on a bracket beyond the end of the bar. Holtzapffel, in the second volume of his book on "Turning," published in 1856, gives a sketch of the end of a boring bar with a screw lying close to the bar, but not in a groove, and shows a large spur wheel on the screw engaging with a pinion mounted on an axis coincident with that of the bar. Such a construction would involve a very large journal to embrace the screw bearing, and it would be an improvement to put the screw in the keyway along the bar, as was done on the Soho bar mentioned above. Holtzapffel said that he was told by Mr. John Taylor, F.R.S., that the machine was invented by George Wright, when in the employ of Boulton and Watt at Birmingham. A man named Wright is mentioned as one of the early Soho mechanics, but when he was employed there is not known. Holtzapffel's sketch, however, represents a machine boring the semi-circular casing for a D valve, so that its date would be later than 1800. The large vertical boring bar at Soho, said to have been erected between 1860 and 1870, had the same screw arrangement, which by that time had become the standard form.

It seems, then, that the early Soho bars were sometimes hollow, but their screws were fitted in shallow grooves, which also served as keyways for the cutter heads. There is no definite evidence that they existed as early as 1800, as tradition asserts, but if Murdock or Wright had actually introduced the screw by that date its use was probably kept as secret as possible. Joshua Field, in 1821, saw one large and four small boring bars at Soho Foundry, but did not describe them. The statement that the screws were hand-cut indicates that they were made before there were any large screw-cutting lathes, and William Buckle, who became manager of the Soho Foundry in 1824 or 1825, is credited with making the first large screw lathe there. The cutting of these long screws by hand was evidently a special art practised at Birmingham about the end of the eighteenth century, and the available evidence tends to support the belief that the ultimate form of the screw-feed boring bar originated there.

It has been supposed that such screws were laboriously cut entirely by chisel and hammer, and finished with the file, but this is not strictly correct, as will be seen from the following description of the method used in cutting a large screw, extracted from T. Gill's *Technological and Microscopical Repository* of 1830:—"About 40 years since (*i.e.*, 1790) an ingenious smith at Birmingham named Anthony Robinson was employed by the late Matthew Boulton to make him a large wrought iron screw for a press, of about 6in. diameter and 7ft. long. The bar having been turned, a long parallel strip of paper was fitted to it, its edges exactly meeting on a line parallel with the axis. The paper was then removed and across it were drawn sloping lines to form a triple thread. The paper was then cemented to the cylinder, and the lines pricked out with a punch. After removing the paper, the punch marks were joined up by a file edge so as to form helical lines. The metal between the pairs of lines was then cut away by a chisel until sufficient depth was obtained to form a lead. A long typemetal nut was then cast in an iron box placed round the screw which was erected vertically so as to be rotated in the nut by 6 men working on capstan handles fixed to the screw. The nut box was fixed to a beam and adjustable cutters were mounted on it, by means of which the screw was soon brought to proper shape."

It is obvious that by this method much labour was saved and a better screw produced than if cut entirely by chisel and hammer; the long nut tended to smooth out the errors in the preliminary cut, the marks of which would probably be entirely removed.

If the screw feed was actually introduced at Soho about the year 1800, the method of its application must have been kept very secret, as cylinder boring machines were made by other engine builders at about the same period of shortly afterwards, which, although embodying a screw feed, applied the screw in a variety of different ways.

After the date of Billingsley's patent, the author has found no contemporary illustration of a cylinder boring machine until 1817, when John Farey made a drawing of one of Matthew Murray's machines for the sixth edition of the "Encyclopædia Britannica." This is shown in Fig. 4. The machine has a solid bar with two longitudinal grooves along opposite sides of it, and in each of these grooves there is laid a rack bar with its teeth facing inwards. The racks are fixed to the sliding cutter head, and revolve with the bar, while the rack teeth, which virtually form a long nut, engage, beyond the end of the boring bar, with a short screw mounted on a central spindle. This spindle extends rearwards so as to allow the racks to attain the full travel of the head, and its outer end is connected by gearing and a long upper shaft with a spur wheel mounted on the end of the boring bar. The bar is 8.5in. diameter and 9ft. long, and is shown boring a cylinder 17in. diameter by 5ft. long. As Murray started his engine factory at Leeds in 1795, this machine may have been constructed then, or shortly afterwards. Farey, writing in 1816, said that Murray had three machines for boring cylinders. He is also known to have been making boring machines for export as early as 1806.

In 1818, Farey made, for Rees's "Cyclopedia," a drawing of Mr. John Dixon's boring machine used at the Falcon Iron Foundry, Maid-lane, Southwark. As he also illustrated a steam engine at the same factory for Nicholson's "Encyclopedia" in 1808, it is probable that this machine existed at that date.

A copy of Farey's drawing is shown in Fig. 5. It will be seen that the machine had the Wilkinson hollow bar, but had two slots on opposite sides. It had a central screw of the full length of the bar, but instead of being rotated and passing through a nut on the cutter head, it was loosely pinned to the head, prevented from rotating by a crosshead on its outer end, and passed through a nut which was mounted on a fixed post and turned by a hand wheel. The bar was 9in. diameter and 9.5ft. long, and is shown boring a cylinder 19in. diameter by 5ft. long.

Wilkinson's rack feed machine and both Murray's and Dixon's machines were practically twice as long as their bars. Murray's, however, was superior in that it had a positive automatic feed, while Dixon's had only a hand feed.

The next machine to be noted is of another design, also attributed, by later writers, to Matthew Murray. In this the cutter head is fixed to the middle of a very long boring bar, which rotates and at the same time slides through its two bearings by the agency of a screw and nut. Although brief descriptions of this form of machine are to be found in English works, the earliest complete drawing of one, extracted from a French publication, was given in Gill's *Technical Repository* for 1822. The machine described was in use at the engine works at Chaillot belonging to M. Périer, and was said to be the machine which the English mechanics then used for the purpose of boring cylinders. It is stated that only two such

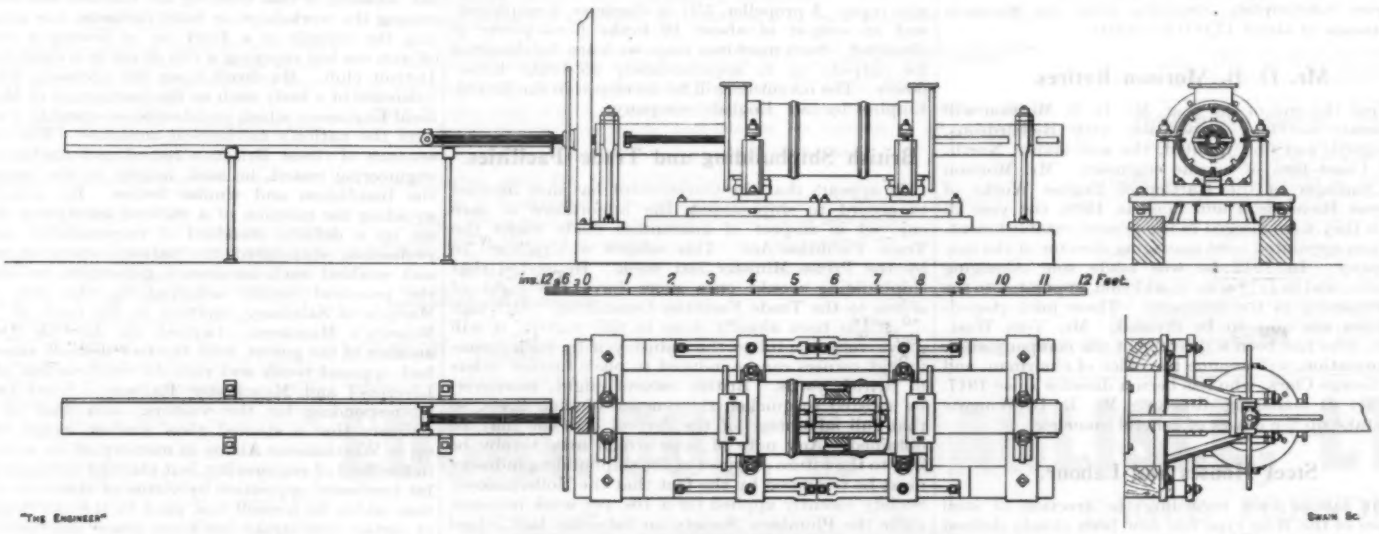

FIG. 5—DIXON'S BORING MACHINE, 1818

* The Newcomen Society. Read Wednesday, Dec. 17th, 1924.

machines existed in France, the one at Chaillot and another at St. Quentin. It is highly probable that both these machines had been made by Murray, who was one of the principal machine tool makers of the period.

The French writer evidently appreciated the positive automatic feed, as he stated that "the movement of the boring head being uniformly continued, the result is that the work is more quickly performed, and is more perfect than when done on the old machines where one was obliged to raise, from time to time, the weight which impelled the boring head."

A much better drawing of the Chaillot machine was published, however, in the "Bulletin de la Société d'Encouragement," in 1823, and a copy of this is shown in Fig. 6. This machine had a boring

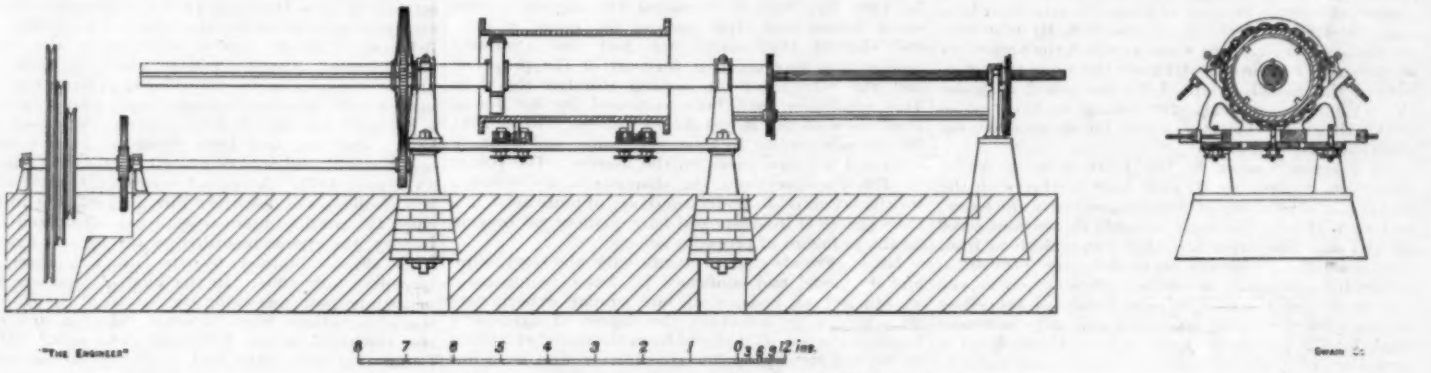

FIG. 6—MURRAY'S BORING MACHINE AT CHAILLOT, 1822

bar 5.5in. diameter and 13.25ft. long. Its two bearings were 6ft. 4in. apart, and the maximum travel of the head was 5ft. The boring head was keyed to the middle of the bar and the whole bar was moved endwise through its two bearings and through the driving wheel, which was mounted close up to one of the bearings and the key of which fitted a slot cut along the bar. A screw, 1.75in. diameter and 6ft. long, with a pitch of 0.5in., was fixed to the end of the bar and had its outer end supported by a nut which could turn in a fixed bearing. The nut had a gear wheel with thirty-eight teeth fixed to it, which engaged with a 36-tooth wheel fixed to the end of a square countershaft, along which could slide a second wheel with thirty-eight teeth that constantly engaged with a wheel of thirty-six teeth fixed on the end of

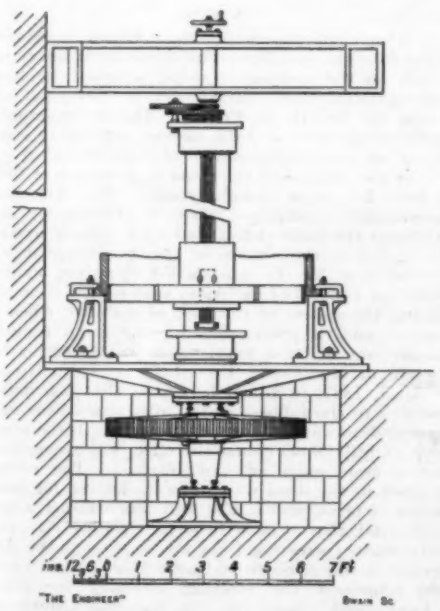

FIG. 7—NASMYTH AND GASKELL'S BORING MACHINE, 1841

the boring bar. The sliding wheel was pushed along by a flange on one side of it. The bar was driven from a vee-grooved stepped pulley through a double reduction gearing. As the bar rotated, the feed gearing caused the nut to rotate relatively backward at about one-eighth of the speed, so giving a feed of 0.065in. per revolution of the bar. The bar being drawn through the driving wheel, held the latter in position against the bearing. A cylinder 20.5in. diameter and 4ft. long is shown on the machine. It is supported on adjustable vee blocks, to which it is secured by chains with tightening screws.

This form of machine no doubt produced good work, but certainly appears to be clumsy; its overall length being 22ft., for an effective travel of only 5ft. It was probably only used for the smaller machines, but curiously enough it seems to have been better known than the other contemporary screw-feed machines. This is possibly due to the fact that machines of this country, and must have carried with them a knowledge of the machines employed there.

The writer is, however, not aware of any mention or description of such a machine until 1829, and here, again, we are indebted to a foreign source for the information. In 1828, two French engineers, MM. Coste and Perdonnet, visited England to study the mines, ironworks and railways of the country, and published an account of their observations in "Annales des Mines," for 1829. They described the machinery used in ironfoundries and engine factories, including cylinder boring machines. At several places they found only the Wilkinson type of machine in use, either with the ancient rack, lever and weight feed, or else improved by the rack pinion being positively driven by the machine. They also saw Billingsley's vertical rack-feed machine at Bowling, working just as it was in 1802.

At the works of Messrs. R. Stephenson and Co., at Newcastle, they noticed a machine with a hollow bar, sliding head and central screw of the Dixon type, but the account does not say whether the feed was automatic. At Fairbairn's works at Manchester was a small boring lathe, in which the cutter head was fixed on a bar placed between the lathe centres, while the cylinder was mounted on a sliding table moved by a leading screw in the bed.

At an unnamed works at Glasgow, however, they saw a machine with a solid bar about 12in. diameter, along which the boring head was moved by two screws, about 1in. diameter, sunk in grooves 1.5in. square, cut along the bar. The screws carried toothed pinions on their ends, which engaged with an internally-toothed ring mounted on one of the pedestals that supported the bar. When boring, this annular wheel was rotated by external teeth and gear wheels at a suitable speed for the feed required. The reporters were unable to obtain a drawing of the machine, and so gave a diagrammatic sketch only, but it is the earliest illustration of the type known to the author and it also shows the duplicate screw arrangement which was afterwards much used. Curiously enough, the French engineers make no mention of having visited Murray's works at Leeds or the Soho Works at Birmingham.

Shortly after this time, Hebert, in his "Engineers' and Mechanics' Encyclopedia," published in 1835, gave a description of the second type of Murray machine—Fig. 6—and also described and illustrated a large iron-framed vertical boring machine, which was said to have been erected in an extensive engineering establishment, and which he thought had not appeared in print before. The woodcut is a poor one and not worthy of reproduction. It shows a machine with a solid bar and a single feed screw lying in a groove. The feed motion was derived from the rotation of the bar by a fixed bevel wheel at the top of the frame, through epicyclic gearing, consisting of a bevel pinion, worm and worm wheel.

For a good illustration, however, we have to wait until 1841, when Robertson Buchanan published the third edition of his "Treatise on Millwork and Other Machinery." In this he gave drawings of three large vertical boring machines, and pointed out the advantages of the vertical type for boring large cylinders, viz., the avoidance of distortion of the cylinder or boring bar under their own weight, the gravitational clearance of the cuttings, and the smaller floor space occupied. He also claimed that less power was required to drive them. Fig. 7 shows a machine by Nasmyth and Gaskell, of Manchester. This had a solid bar, 16in. diameter, with automatic screw feed, the screw being housed in a slot in the bar and operated by epicyclic spur gearing and a fixed pinion at the upper end of the bar. In this case the machine was placed in a corner of the shop, the walls serving as the frame, and the top end of the bar having its pivot mounted on a diagonally placed cast iron girder. The driving spur wheel below was driven by a worm, and the machine is shown boring a cylinder 73in. diameter.

The other two machines illustrated by Buchanan were not, however, normal screw-feed machines. One by Nasmyth and Gaskell had a central rack with automatic feed gear mounted on the top of the bar, and deriving its motion from a fixed screw ring. This machine was made for boring the 10ft. diameter cylinders for the Great Western Navigation Company's vessel Mammoth, then under construction at Bristol. The other machine, by Benjamin Hick and Son, of Bolton, had the Murray double-rack and short screw arrangement, similar to that shown in Fig. 4.

It would appear, then, that by about 1830 the cylinder-boring machine had arrived at its final form, although even then that form was not widely known. Since then practically no change has been made in it, except for variations in the arrangement of the feed gear. The horizontal position was adopted for small machines and the vertical position for the large machines.

It is clear that to Wilkinson is due the main principle of the machine, but we cannot be certain as to who introduced the automatic screw feed. The writer is inclined to doubt the Murdock tradition, which is only supported by our knowledge that the necessary screws could have been made at Birmingham at the time, while the fact that the old Soho bars were hollow, inclines one to think that they had originally the central rack feed of Wilkinson, and that they were subsequently fitted with Wright's screw arrangement.

There the matter must rest until further evidence comes to light. It is rather curious to find that over the whole period 1775 to 1840 only one patent, that of Billingsley in 1802, was taken out for cylinder boring machines.

The Work of W. and R. E. Froude.

By A. W. JOHNS, C.B.E., R.C.N.C., M.I.N.A.

No. III.*

PROPELLER EFFICIENCY.

THE necessary apparatus for determining the efficiency and performance of screw propellers had been installed in the model tank at Torquay in 1873, and some results of experiment there had been mentioned by Mr. W. Froude in the papers and discussions at the Institution of Naval Architects and elsewhere, but it was not until 1883 his son gave some details of the apparatus and method of experiment. In that year he read a paper at the Institution of Naval Architects in which he described and gave a sketch of the apparatus which had been used and the methods of determining the thrust, turning moment and efficiency of screw propellers, and the mode of presenting the results graphically. He discussed the interaction between the propellers and the ship, and pointed out that the presence of the former generally increased the resistance of the latter; whilst the motion of the ship caused a wake which modified the thrust, turning moment and efficiency of the propellers, as compared with the same quantities when the propellers at the same revolutions were moving forward at the same speed in open water. He stated that of the two, the effect of the propellers on the ship's resistance was that which had first been studied at Torquay, and it was not until later—apparently after the Iris trials in 1877 and 1878—that the screw propeller efficiency and the effect of the ship's wake upon it had been investigated. The rest of the paper dealt with the method of determination of the agumented hull resistance and the velocity of the wake. The former was obtained by towing the model at constant speed (V) with the propellers in their appropriate position

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behind, and measuring the resistance of the model and thrust of the propellers over a range of revolutions of the latter. Resistance and thrust were then plotted as curves on a base of revolutions.

At a certain number of revolutions (R) the two curves intersected, and at such a point the thrust of the propellers equalled the resistance of the model and the latter was virtually self-propelled. The difference between the model resistance at this point and its resistance at speed V without the propellers was the increase caused by the latter, and was the augmented resistance of model, or, as Mr. Froude preferred to term it, the thrust deduction, since it had to be deducted from the total propeller thrust to obtain the resistance of the bare model. The wake velocity was determined from two curves of propeller thrust, one behind the model moving at speed V, the other over the same range of revolutions, but with the propellers moving forward at a less velocity than V in open water, *i.e.*, with the model removed. By determining the speed V_1 in open water at which the propellers at the same revolutions (R) gave the same thrust as behind the model at speed V, the speed of wake $(V - V_1)$ was obtained. By taking various values of V, the wake velocity could be determined for different speeds of ship.

In a second paper at the Institution of Naval Architects in 1886 Mr. Froude dealt further with the experimental methods of determining screw efficiency, and showed how the most suitable dimensions were arrived at. The paper included curves derived from a number of experiments on model screw propellers, in which, by adopting a constant efficiency curve, the curves of thrust results from a family of propellers in which the pitch ratio had been gradually increased from 1 to 2.4 were shown corrected to apply to a propeller of 10ft. diameter. Accompanying the thrust curves were the corresponding curves of revolutions and also of the slip ratios. The results applied to four-bladed screws, but he stated that investigation had shown that the thrusts of three and two-bladed screws were 86½ and 65 per cent. of those given and the curves could be corrected and used for the others. Finally, he indicated how these curves could be utilised to obtain the propeller dimensions when the wake velocity and horse-power were known. Values of wake velocity for typical warships were given, and also those of the propulsive efficiency for various ships whose trial results had been examined. The values of the latter in the four trials of the Iris referred to previously were 32, 45, 49 and 50 per cent. respectively, and the smallness of the coefficient for the two first trials was due to inefficient propellers. The highest value obtained up to that time was with the Phæton, in which the propulsive coefficient was nearly 60 per cent., her propellers being designed with a view to secure maximum possible efficiency by the model results. The propeller efficiency as determined from model results, compared with these values of propulsive coefficients obtained from steam trials of the ships, showed conclusively that high values of the atter were secured by high propeller efficiency.

In 1899 at the Institution of Naval Architects Mr. Froude gave further results of experiments on screw efficiency. Just before this, inward turning screws had been fitted in some warships, this direction being of some advantage in arranging the engine-rooms. As a result of experience, it was stated that the change from outward turning resulted in some disadvantages in the vessel's navigation. The experiments were carried out to ascertain the difference in propulsive effect of the two directions of turning. Models of all classes of warships were used, and the results as given by Mr. R. E. Froude show that in some instances one direction was the better, whilst in others the reverse held, but that generally there was no great difference. Amongst the results given were values of the wake, thrust deductions, hull efficiency, dimensions and prismatic coefficients of the models which are valuable to the naval architect for design purposes. In this paper Mr. Froude first made use of the term "relative rotative efficiency," which serves as an indication of the variation of the wake velocity over the area of the propeller disc. It may be mentioned that as the manœuvring powers of ships were reported to be unfavourably influenced by inward turning screws, and as, moreover, not long afterwards turbines replaced reciprocating engines, and the slight advantage in engine-room arrangements referred to was no longer applicable, outward turning propellers are now always fitted in warships.

In 1908 there followed another paper on propellers in which a simpler method of determining dimensions was described by Mr. Froude. In this paper the results of a number of experiments with propellers were given, the model screws being thirty-six in number, the series including three different blade width ratios, three disc area ratios, and four pitch ratios, the smallest of the last being less than those reported in the paper of 1886. Three-bladed as well as four were included, and some shapes of blades differing from the standard elliptical form were also experimented with. The novelty of the paper was the description of a much simpler method of analysis than that formerly described, the thrust of a screw being expressed by two terms, the first containing the first power of the revolutions and the second their square, both terms being multiplied by certain coefficients, which varied with the particular type of screw, and whose values for the series of propellers used in the experiments were tabulated. In this paper we find the first mention by Mr. Froude of analysis or effective pitch, which differs from the geometrical pitch of the flat propeller face, and is determined by experiment. If at revolutions R and speed of advance V the propeller exerts no thrust, the analysis or effective pitch is given by $\frac{V}{R}$. It is usually greater than the geometrical pitch of the face, the difference being caused by the rounded back of the blade, and therefore varies with the degree of curvature, &c. Its definition was necessary for the simplification of the formula for thrust in which it is employed.

Other papers on screw propellers were read in 1889, 1892 and 1911, but they were of a more academic nature than those which have been already mentioned. In 1889 Mr. Froude discussed the motion of the water before and after passing the propeller disc, and showed that about one half the sternward acceleration was given it forward of the propeller and the other half on passing through the disc. This conclusion had been criticised by Sir James Henderson of the Royal Navel College, and in 1911 Mr. Froude replied to these criticisms, and strongly defended his own views on the matter. The points of difference between the disputants are difficult for the lay mind to understand, are of more academic than practical interest, and have little or no bearing on the problems of propeller design.

Mr. W. Froude's experiments with the Greyhound and its model had confirmed his law of comparison as applied to resistance, but similar experiments with screws to ascertain the degree of agreement between the results deduced from the model and those of the full sized propeller are difficult, and have not as yet been carried out. In discussions at the Institution of Naval Architects Mr. R. E. Froude was asked for information on this important point, and he replied that the only opportunity for comparison was in examination of the results of the steam trials of ships, but in them so many factors were involved that any deduction as to propeller thrust or efficiency was of doubtful value. The examination of trial results of typical ships is a necessary complement to the experimental work of a model tank, and it is understood to be the case that generally the thrust of the propellers as deduced from trial results are found to be slightly in excess of those deduced from the model propellers.

The model screws used at the Haslar tank are ⅛ft. in diameter, and the speed of advance 300ft. a minute, whilst those which were used by Admiral Taylor at the Washington tank were 16in. diameter, and the speeds of advance 3, 4, 5, 6 and 7 knots. Professor T. B. Abell at the Institution of Naval Architects in 1910 compared results from both tanks, and the comparison indicates a slightly increased efficiency from the larger model screws. The difference between the models is, however, small in comparison with the model dimensions and those of full-sized screws. The results of experiments at various aerodynamical laboratories show that as speed or dimensions or both are increased, the coefficient for lift of aerofoils increases, whilst that for drag decreases. If these results are applied to a propeller it should follow that thrust increases and turning moment decreases relatively, and efficiency is improved by increase in size or speed. Experiments with aerial propellers confirm this. It may, therefore, be concluded that for ship propellers the same obtains, and results based on model performance should be improved upon in the full-sized screws.

Rolling.

Mr. W. Froude had written so fully on the problems of a ship's rolling that little remained for his son to investigate. Only one paper on the subject was prepared by him. It was entitled "Non-uniform Rolling," and was read at the Institution of Naval Architects in 1896. It is a somewhat abstruse paper, but important from the point of view that it practically completes the theory of the rolling of ships which had been initiated by Mr. W. Froude.

Mr. R. E. Froude carried out important rolling experiments on two ships, the battleship Revenge and the destroyer Star. Both vessels were tested prior to and after the fitting of bilge keels, the object of the experiments being to ascertain the effect of that addition. Reports on the experiments were made by Mr. Froude to the Admiralty, and it was on his Revenge report that Sir William White based his paper of 1895 at the Institution of Naval Architects. Some of the effects observed in the Star experiments have been published by others. Previous to the experiments on these two vessels, rolling tests had been made with the ships at rest, *i.e.*, with no speed ahead, but in both these later tests the observations were extended, and the effect of the keels on the rolling when underway at various speeds was observed. Mr. Froude found that in both the effect of the keels in decreasing rolling was augmented when underway, and the period of roll slightly decreased. The curious reader might well ask why, in view of the complete acceptance of model results for other motions of a ship, the effect of bilge keels on the rolling of the Revenge was not investigated by model experiments in the design stage of the ship? So far as can be traced no explanation has been given, but it is probably to be found in the lack of precise knowledge at the time as to the laws appertaining to the type of resistance offered by bilge keels to rolling, and the uncertainty of results obtained from models applying to the ship. The Revenge experiments more especially indicated that the effect of such keels on limiting rolling was far greater than had been supposed. Examination of the results of the experiments on both vessels showed the great utility of bilge keels, and they have been fitted in all later types of warships.

The Froude Log.

It was characteristic of Mr. Froude that not feeling fully satisfied with his previous reports and conclusions on the rolling experiments on the Revenge, he reviewed the whole of the observations after his retirement from Haslar in 1919, and prepared another and more exhaustive report which he forwarded to the Admiralty, nearly thirty years after the actual experiments. Another matter which he took with him to consider in his more leisured time was connected with observations and experiments made on a pressure log intended to indicate the speed of a ship. This log had been designed by his father and himself, and was first used on the Iris trials in 1877 and 1878. A second series of trials with it was made on the destroyer Flirt in 1902, but in both ships the results obtained were not considered satisfactory, the speeds recorded by the log not agreeing with those obtained by the usual method, *i.e.*, measured mile runs. In the Flirt the log was tried in various positions along the length of the ship and the observations were of some value in indicating the thickness of the frictional wake belt. It was found that this wake had a greater lateral extent than had been previously thought to be the case, and its thickness varied with the position, being greater the further the log from the bow. The effect of the wake prevented anything like an accurate indication of the speed of the ship being recorded by the log, and to get clear of the wake involved some practical difficulties. It is probable that if greater opportunities had been available to Mr. Froude for continuing his experiments with the log, improvement in the apparatus and its indications might have been effected and sufficiently accurate results obtained. The ordinary routine work of the tank occupied most of his time, and the difficulty in detailing ships for long periods of time in carrying out the necessary experiments was another factor which militated against the improvement of the apparatus. The experiments were of importance in showing the difficulties which instruments designed on a similar principle, that of the Pitot tube, are subjected to when projecting from the bottom of a ship.

Steering.

Although no papers on the subject were read at the Institution of Naval Architects by either father or son on the steering of ships, several interesting investigations were carried out at Torquay and Haslar by Mr. R. E. Froude. The Northampton, on her completion in 1879, proved difficult to steer, taking up appreciable angles of yaw either on one side or the other, and requiring large angles of helm to keep her on a straight course. The Ajax and Agamemnon, completed shortly afterwards, also exhibited the same defect, but to a greater extent. On receipt of the reports of this behaviour it was decided that Mr. Froude should carry out experiments on a model of the Ajax, with a view to ascertaining the causes of the lack of stability when in motion, and, if practicable, to discover a remedy. An account of these experiments was given by Mr. Froude at the Royal United Services Institution in April, 1887, in which he stated that the defect was due to the fullness of the after lines, causing a mass of dead water to form at the stern. If the vessel went slightly off her course this effect was exaggerated and a large angle of yaw resulted. The rudder situated in the dead water was ineffective for small angles of helm, and it was only when larger angles were used that it was brought clear of the dead water and a correcting force was applied to the ship. Several forms of deadwood were fitted to the model and improved the steering qualities by giving a longer and clearer run aft, and diminishing the amount of the dead water. Having thus ascertained the cause of the instability of the ship's motion, a form of deadwood which it was practicable to fit in the ship was tested. The defect was largely if not entirely removed, and when the same form was fitted and tried in the ship it proved satisfactory. In these experiments the model was towed from the travelling carriage of the tank by a horizontal bridle pivoted at its middle to the fore part of the model, and connected by wires from its ends to the truck. The ends of the bridle were also connected on opposite sides to those of a much shorter transverse bridle keyed to the rudder head. By throwing the model off its straight course, the rudder always moved to diminish the yaw, and the model oscillated from side to side, the rudder always tending to bring it to the middle. The successive oscillations were recorded and their rate of decrease gave a measure of the stability of the motion.

Other experiments have since been carried out to determine the pressures and moments on rudders

of various ships, and also the effect of diminishing the area and altering the shape of the deadwood. The model tank is not, however, so suitable for rudder as for other tests, for the path of a ship under the action of the helm is difficult to reproduce without a self-propelled model too large for a tank, and for this reason the actual pressures on the rudder and forces on the ship are not correctly represented by the towed models.

INCLINED PLANES.

One of the earliest investigations carried out by Mr. W. Froude had for its object the determination of the normal force on inclined plates moving through water. It was from the results of these experiments that he obtained the coefficients used in obtaining arithmetical results from his propeller theory in 1878. Some years later Mr. R. E. Froude made a more extended investigation of the same phenomena using small surfaces about 16 square inches in area. Square, rectangular, circular and elliptical shapes were used, some having plane faces and backs and others plane faces and curved backs, the cross sections of the latter being similar to those of propeller blades. The normal and tangential forces at various angles of inclination from 0 deg. to 90 deg. were measured. The experiments were carried out at two speeds, 150ft. and 300ft. per minute, but the coefficients at the two speeds differed but little, and such differences as existed were within the limits of experimental error. The results of these experiments were published by his friend, Mr. A. Mallock, in the first annual report of the Advisory Committee on Aeronautics. They are useful and instructive for comparison with the corresponding results obtained by the various aerodynamical laboratories for similar plates moving through air. When the necessary correction for the different densities of the two media is made the results are in very close agreement.

In connection with his investigations on the difference between the power of a ship's engines and that usefully employed to give her motion, Mr. W. Froude designed a dynamometer to measure the power of large engines. One such apparatus suitable for engines of 2000 horse-power was constructed, but the results obtained by its use were never published. Many dynamometers to the same design have since been constructed by a firm in which his eldest son is a partner, and have given most satisfactory results.

Mr. W. Froude and his son were both keen yachtsmen, and the latter had at various times several of the smaller classes of yachts, which, although not exceedingly brilliant in their performances, were sufficiently so to secure a few honours in Solent races. It is not known if the forms of these yachts were determined from the results of experiments in the model tank, but probably for the reasons which were previously referred to in connection with sailing ship model tests they were not. Mr. R. E. Froude was, moreover, a recognised authority on the rules relating to yacht measurement and rating, and contributed one paper on this subject to the Institution of Naval Architects. Several others have appeared in periodicals more particularly concerned with yachting. He was one of the delegates from the Yacht Racing Association who assisted in framing the International Racing Rules.

CONCLUSION.

In the foregoing brief account reference has only been made to the most important of the investigations and experiments by which the science of naval architecture has been considerably advanced during the past fifty years by W. and R. E. Froude. The papers presented by the two to the Institution of Naval Architects have been principally referred to, for it was both natural and correct that matters in which the members of that Institution were primarily and principally concerned should be described and discussed there. These papers are, however, only a portion of those which were prepared by the two investigators, for many were read at other institutions. In several instances the same ground was covered, but the presentation took a different form, more suited to the audiences for which it was intended. The results and arguments are thus viewed from a different aspect, and for that reason are of additional value. The discussions on papers read at various institutions and dealing with subjects in which the two were interested also offered opportunities for father and son to give further or fuller details of their experiments and investigations, thus supplementing to a great degree the information contained in their own papers. In such discussions, their remarks were, without exception, helpful and instructive, and always encouraging to the author of the paper under review. The records of the British Association, Royal Society, Royal Institution, Institution of Civil Engineers, Greenock Philosophical Society and other learned and scientific bodies contain ample evidence of their activities, not only in naval architecture, but in other branches of science. As an instance, a paper on the "Soaring of Birds" was read by Mr. W. Froude at the British Association meeting in 1869.

At various times it has been suggested that the papers and other records of the two Froudes should be collected and published, and several persons have expressed their intention to carry out this laudable purpose, but either from lack of time or energy, it has not yet been attempted. It would appear an eminently suitable time for the Institution of Naval Architects, to which so many of their papers were presented and at whose meetings they contributed so largely to the discussions, to take this matter in hand. Such a work would serve as a slight tribute to the half-century's very successful work of the two Froudes and would prove a mine of information to naval architects and engineers.

Individualism in Locomotive Design.

By J. G. H. WARREN.

IN a recently published paper[1] on the design of broad-gauge locomotives at work in the Argentine, the author, after referring to the effects of excessive standardisation on the Indian railways, remarks that "happily there is far more individuality about Argentine design than about Indian, but when the former is compared with the latest Spanish practice, the comparison is more unfavourable. . . . It will be noticed that in the acid test of good design, the amount of tractive effort per ton of weight, the Spanish railways come an easy first."

This is a sweeping statement, for which a superficial comparison may offer some justification, and no doubt does, but "individualism," the remedy suggested for a regrettable state of affairs, can cut both ways, and until its effects on locomotive design have been considered in all their aspects, we cannot accept the obvious implication that the British locomotive builders, who have hitherto supplied most of the broad-gauge engines for the Argentine, are now unable to design locomotives which will compare favourably, on the basis suggested, with their foreign competitors. It was the British builders who taught the world to build locomotives, and if their hands have lost their cunning it should be worth while, for their own sakes, as well as in the interests of truth and common justice, to inquire and determine the reasons, or at least to suggest what they may be, with a view to further inquiry. These reasons can hardly be accidental, and are more likely to be due to fundamental causes in the nature of things human and political, or to conditions beyond their control.

So at least it appears to the present writer, though he can claim no more weight for the suggestions now offered than that they are personal opinions based on many years' practical experience, supplemented by a considerable study of the conditions which have determined and limited the design of the locomotive since its essentials were defined by the early builders.

There is sufficient evidence that any of the first-class British locomotive builders, if given a free hand, can produce to-day, as they have in the past, engines which in the ratio power/weight will compare favourably with the productions of their competitors. Indeed, it is important to note that one of the two particular Spanish engines quoted as worthy of imitation in respect of such a ratio, is of a new class, not only built, but designed by an English firm,[2] and the writer believes that the principal reasons why builders do not more often produce such results are :—

(1) The effect of the policy adopted by some railway companies of designing their own locomotives—a policy, in fact, of "individualism," which, speaking generally, began in and has been most prevalent in Great Britain or on British-run lines.

(2) The indiscriminate use of "standard" parts.

(3) Modifications, or the addition of elaborate fittings, to a "basic design," which add to the weight without a proportionate increase to the power.

Referring to (1), there is no intention in the present article to discuss in its financial aspects the policy of locomotive building by railway companies. We are concerned here solely with the effect of such policy on design. The policy is no new one, and its effects on design have been cumulative. To appreciate them we must remember that after the essential lines of locomotive development had been determined by the Stephensons, their success as builders—and designers—immediately provoked the establishment of many rival firms, and tended to maintain the simplicity of design which is largely synonymous with general efficiency in the locomotive. No maker could afford to give away useless deadweight, or to complicate the parts of an engine which had to be sold on a competitive basis, though that basis was perhaps at first one of efficiency, rather than merely of price, as it unfortunately is to-day.

Now, when the railway companies took to designing and building their own locomotives, one at least of these incentives was lost, and it became possible to sacrifice simplicity to personal idiosyncrasy—often merely to the desire for change. On a railway, errors in design or in the estimation of total and distributed weights became inevitably domestic affairs over which a veil might be drawn. Additional axles might be provided, boilers transmigrate, and cylinder castings form the nuclei of a "rebuild" to an extent impossible to a locomotive builder having to supply engines to a contract price and liable to rejection should they exceed a specified weight.[3]

The result has been much complicated and bad design, and the carrying of many thousands of tons of useless engine weight over the railways of the British Isles has followed. In some cases, however, no secret has been made of these transformations, and proof of this statement is to be found in the descriptions and drawings published from time to time in the technical Press without perhaps a full realisation of their implication.

The frequent repetition of such incidents has only been made tolerable by the excellence of a permanent way, which has allowed actual, though not intentional, axle loads of 22 tons, while the continental and Indian lines have been limited to 16 tons—another incentive to the reduction of useless deadweight. This is not to say that the locomotive engineers of the past have not appreciated the desirability of obtaining maximum power with minimum weight—an ideal which has possessed every railway engineer since the steam engine first became locomotive—but, with some notable exceptions, they, as individuals, have often lacked, as their staffs have lacked, the fund of accumulated and varied experience of the locomotive builders in the design of details. These latter have, nevertheless, all too often had to build to railway companies' designs, and work to specifications and duplicate details which make it impossible to realise an ideal which should be common to both parties concerned; for, although it remains within the province of the builder to make suggestions in modification, such suggestions are liable to be looked upon as suspect and declined.

Now these factors are affecting the design of British-built engines for the Argentine, as elsewhere, perhaps in increasing degree with the growing desire, and, it may be admitted, the need, for some sort of standardisation. We are thus led logically to consider :—

(2) THE INDISCRIMINATE USE OF STANDARD PARTS.

Here the writer is largely in agreement with the criticism quoted at the beginning of this article; but this is not to admit that the standardisation of locomotives for the Indian railways has been of no use. It is claimed[4] to have checked some of the useless individualism to which reference has been made above, an individualism which in the past has only too often multiplied types without increasing efficiencies.

At the same time it it is legitimate and fair to inquire what we lose under standardisation. In this question we have to consider not only the conflicting opinion of the designers, who are concerned only with producing what they conceive to be an ideal locomotive, but we have to consider the fundamentally different points of view of the engineer and the storekeeper, and again, that of the manufacturer, whether as railway company or as contractor. Somehow a compromise has to be effected, and it is one purpose of the present article to inquire how far the ratio power/weight is likely to suffer in the attempt to reconcile the different interests referred to above.

It is obvious that the storekeeper's point of view can be quickly reduced to the absurd when it is proposed to adopt for an engine having 18in. cylinders with piston valves and designed for a 13-ton axle load, the parts of a valve motion designed originally for the flat valves of a 21in. cylinder and the axles and axle-boxes suitable for an 18-ton axle load; or when the valve gear for an engine of a new class has to be designed to duplicate an existing pattern of reversing link.

The need for the duplication of working parts was realised in the early days of the Liverpool and Manchester Railway, when almost every engine differed in its detail from that which had preceded it, though something like a standard type had been attained by 1831 in the "Planet" class, to be followed by other and more powerful standard types as the demand for power increased from time to time. The standardisation of parts within such types, or classes, is as desirable, and perhaps even more possible, to-day when experience has eliminated much of the need for such experiments as were necessary between 1830 and 1845. It has been obvious, too, for many years that standard engines of the simpler types, 2–4–0, 4–4–0, 0–6–0, could have been designed to work on some of the main lines of this country from Aberdeen to Exeter, yet as long ago as 1855 D. K. Clark wrote :—"I suppose the varieties of locomotives in actual operation in this country and elsewhere are very nearly five hundred in number. Everyone cannot be right and some of them must be wrong, and it would be for the best interests of railways if the proper authorities could be unanimous in the selection of a good number of classes to uniform patterns to be adopted in future practice."

Clark proceeds to doubt whether such arrangement could be worked out unless under an "entire amalga-

[1] *Journal*, Inst. Loco. Engineers, Vol. XIV., p. 209. Poole on "Argentine Broad-gauge Design."

[2] See THE ENGINEER, February 3rd, 1922, for three-cylinder 4–8–0 type engine by the Yorkshire Engine Company.

[3] A well-known American authority, after admitting the value of the early work done by the English builders in developing the locomotive on sound mechanical lines, remarks that after the railroads took up the design and construction of their own locomotives, "the well-built English road-bed made it possible to operate designs, which lived for a time because the fact that the locomotives were operated by their designers and builders softened the evolutionary processes by which the less fit are eliminated." (Fry, *Railway Age*, Vol. 76, p. 730.)

[4] "Proc.," Inst. Mech. Engineers, 1910, No. 4, "The Standardisation of Locomotives in India."

mation of railway interests." It is probable to-day that under the extensive amalgamations which have taken place the policy which he advocates will be put into effect; indeed, we are already beginning to see in practice what has often been said to be impossible. Those responsible for carrying out such a policy to-day must have ample cause to regret the past riot of individualism among British locomotive superintendents which Clark condemned sixty years ago.

But while we can see the obvious desirability for some standardisation of types, or classes, and of their details, we have to face another problem when we begin to mix either the parts of different types indiscriminately, or to duplicate "front ends" or "back ends," although a good deal may be done in this way if each case be considered on its merits. But this method of designing is full of snares and, having been taken as the basis for much standardisation, it has tended to reduce the value of the ratio power/weight in British practice.

A striking example is to be found in the processes of evolution which have led up to the "Pacific" type engines of one of the Northern lines.[5] Some years ago this particular company adopted the 4–4–2 type with three cylinders, all driving on to the leading coupled axle. The engine was a "design" which proved to be most satisfactory in service, so much so, in fact, that a similar arrangement of drive was adopted by the same company as a standard for succeeding types. It was applied to engines having six wheels coupled,[6] although a drive on to the leading axle in such case is not mechanically ideal, and involves a longer wheel base than would be required for a drive on to the middle axle.

But when this arrangement is applied to an engine of the "Pacific" type the evil becomes more apparent, and the actual example illustrated is, for its capacity, probably the longest, as it appears to be the heaviest "Pacific" in existence. It certainly will not bear comparison with engines of the same type recently built for the Indian State Railways.[7] These engines, of much the same capacity, built moreover for the broad gauge of 5ft. 6in., weigh about 7 tons 8 cwt. less, the ratios of total heating surfaces to total weights being for the broad gauge engine 29.8, for the standard gauge engine 28.3 respectively.

A similar though less objectionable example of a "growth" is to be found in some of the 4–6–2 type engines of the Argentine Railways, in which the duplication of a driving and coupled wheel arrangement has led to a disposition of parts which would obviously not have been adopted in a new design. A consideration of such examples leads to the conclusion that to produce the best results in an engine of a new type the designer must be prepared to sacrifice both the views of the storekeeper and his own inclination, may be, to duplicate a connecting or even a coupling rod.

As another example of the price to be paid for standardisation on such lines as these, we may consider the 2–8–0 type engines of the Great Central Railway—Fig. 2. These engines are a development from the previous standard 0–8–0 type of this company, by the addition of a leading truck and the provision of a larger standard boiler designed for another class of engine. Now, it is an elementary fact that an engine of this type has a tendency to be heavy in front, and that in order to correct this tendency and obtain a more equable distribution of weight the boiler has to be kept well back and, in some cases, deadweight must be added in the form of a heavy drag casting. But this combination is unnecessary and highly undesirable in an engine of the 2–8–0 type, which tends to be heavy at the back end and requires that the boiler be placed relatively forward, and that every effort be made to lighten the drag box—as in Fig. 3—otherwise it becomes necessary to provide a balancing deadweight at the front end, as is actually done in the 2–8–0 engines under consideration. In these engines consequently the ratio value heating surface/weight falls to the very low figure 25.6, an equivalent saturated surface of about 1886 square feet only being provided in an engine weighing over 73 tons, and having cylinders 21in. diameter by 26in. stroke.

Now, as an example of what British locomotive builders have done in the past, we have an engine of the same type and cylinder capacity, the same diameter of coupled wheels, 4ft. 8in., and the same working pressure; built, moreover, for the Indian broad gauge of 5ft. 6in., provided with a heating surface of over 2200 square feet and weighing in working order just over 67 tons, that is, 6 tons less than the engine referred to above, of the same nominal tractive power yet with a boiler having upwards of 300 square feet more heating surface. These engines—Fig. 1—built twenty years ago for the Bengal–Nagpur Railway,[8] are still at work, and it has been officially stated and published that they regularly handle with ease the standard load of 1500 tons over gradients of 1 in 200, and they have been known to haul 2287 tons starting at the foot of a 1 in 200 gradient on a 2 deg. curve, the whole of the load being on the gradient and on the curve. So successful were these engines when first put to work that they were adopted as a basic design for a new class then under consideration for the Indian State Railways, and their only fault appears to have been their simplicity, though this may incidentally have contributed to their good performances and to their running 80,000 miles between shop repairs.

COMPARATIVE TABLE SHOWING THE VALUES OF THE RATIO $\frac{\text{HEATING SURFACE}}{\text{TOTAL WEIGHT}}$ FOR REPRESENTATIVE GOODS ENGINES, 1895–1924.

Boiler heating surface being the source of locomotive power, this ratio offers a practical basis for comparing the attempts at various periods to obtain a maximum of power with a minimum of weight. A study of the values obtained during the period of nearly a century which has elapsed since the application of the multitubular boiler to the Rocket in 1829, shows that the value of the ratio varies within comparatively small limits for locomotives of well-proportioned design and approximately equal working pressures. Attempts to obtain a higher, and apparently better, ratio by the use of small tubes, in large numbers and closely packed, soon showed such heating surface to be more apparent than real, and between 1830 and 1833 the water space between tubes was increased from ¼in. to ⅜in., the nominal ratio value falling accordingly. Examples of engines having large nominal values obtained by the packing of tubes may be found in British, American, and continental practice, but they have been omitted from the following table; also examples in which the use of "Serve" tubes makes fair comparison impossible.

Comparison must, of course, be made only between engines of the same type and wheel arrangement, and of approximately equal capacities, and a study of numerous examples of the 2–8–0 type, with approximately 2200 square feet of heating surface, shows that a ratio value of 33 and upwards has been but rarely obtained, either in British or foreign practice, and that only when great attention has been paid to the design of details throughout.

The introduction of superheaters has altered somewhat the basis for comparison between the saturated engines given and later engines, but these have been given the benefit of the doubt by allowing to superheater surface a power value 50 per cent. greater than that of saturated surface. The total equivalent values given for examples 5, 6, 8, 9, and 10 have been arrived at in this way.

Ref. No.	Date.	Type.	Cylinders, diameter × stroke.	Driving wheels, diam.	Name of railway company.	Heat'g sur. (satur'd or equivalent E.S.).	Grate area.	Total weight engine.	Tubes. Length.	Tubes. Outside diameter.	Tubes. Water space.	Working pressure.	Ratio, Heat. surf. / Weight.	Maker's name.	Authority.
			Inches.	Ft. in.		Sq. ft.	Sq. ft.	Tons.	Ft. in.	Inches.	In.	Lb. per sq. in.			
1	1895	0–8–0	18½ × 26	4 0	Mexican	1811.0	25.0	55.8	11 10½	1⅞	⅜	175	**32.4**	Neilson and Co.	*Engineering*, March 22nd, 1895
2	1904	0–8–0	19½ × 26	4 8	Great Central	1764.9	23.6	63.75	15 4½	2	⅜	180	**27.6**	Kitson and Co.	*Engineering*, November 18th, 1904
3	1896	2–8–0	21 × 26	4 3	New South Wales	2198.0	29.75	65.75	13 8 1/16	1⅞	⅜	160	**33.4**	Beyer, Peacock and Co.	*Engineering*, November 6th, 1896
4	1903	2–8–0	18 × 30	4 7½	Great Western	2143.0	27.22	68.3	15 2 5/16	2	⅜	200	**31.3**	Great Western Railway Co.	THE ENGINEER, Suppt., p. xii., December 16th, 1910; also "Proc.," Inst. Mech. E., 1906, No. 2, Plate 25, for original boiler
5	1916	2–8–0	21 × 26	4 8	Great Central type, for service in France	1886.0 (E.S.)	26.5	73.4	15 4⅛	2 and 5⅛	11/16 and ½	180	**25.6**	Various British makers	THE ENGINEER, January 3rd, 1919
6	1918	2–8–0	21 × 25 7/16	4 6½	Czecho-Slovak	2177.0 (E.S.)	27.1	70.25	15 4 1/32	2 and 5⅛	⅝ and ½	184	**31.0**	Swiss Locomotive Works	*Engineering*, August 6th, 1920
7	1903	2–8–0	21 × 26	4 8	Bengal-Nagpur, 5ft. 6in. gauge	2235.0	32.0	67.1	13 0	2	13/16	180	**33.3**	Robert Stephenson and Co.	THE ENGINEER, November 6th, 1903
8	1914	2–8–0	22 × 26	4 8½	Indian State, 5ft. 6in. gauge	2353.0 (E.S.)	32.0	73.2	13 0	2⅛ and 5⅛	—	160	**32.1**	Various British makers	*The Locomotive*, December 15th, 1914. See also THE ENGINEER, February 15th, 1924, p. 184
9	1924	2–8–0	22 × 26	4 8½	Great Indian Peninsula, 5ft. 6in. gauge	2296.0 (E.S.)	32.0	75.5	13 0	2⅛ and 5⅛	—	180	**30.4**	Vulcan Foundry Co.	*The Locomotive*, February 15th, 1924

REMARKS.

1.—Designed in detail by the builders to meet the requirements of the consulting engineers.

2.—Designed by the railway company and built "heavy" throughout. The low value of the ratio $\frac{\text{Heating surface}}{\text{Total weight}}$ is remarkable.

3.—Designed by the C.M.E. to the New South Wales Railway Commission.

4.—One of the exceptionally successful standard classes designed and built by the railway company. Embodies a combination of American with British features; many of the parts duplicate with other classes. The scientific design of the boiler is specially remarkable, and its proved efficiency in service gives no doubt a higher actual value to the ratio power/weight than appears by figures.

5.—Built for the Ministry of Munitions to the designs of the Great Central Railway. A development of Type 2. Note the low ratio value and the small increase in equivalent heating surface in proportion to an increase in weight of nearly 10 tons.

6.—Built for the British Ministry of Munitions for service in France, but sold after the Armistice to the Czecho-Slovakian Government. The design and placing of the boiler and the general arrangement and most details are typical of first-class continental practice.

7.—The first engines of the type for the Indian broad gauge; the wheel and driving arrangements were specified by the consulting engineers; the details were worked out by the builders under a strict weight limitation. The general arrangement of engine and boiler lend themselves to lightness throughout, but the high value of the ratio $\frac{\text{Heating surface}}{\text{Total weight}}$ is particularly remarkable in view of the gauge. It exceeds the average of the contemporary and comparable examples given, and the average of Central European practice up to 1909, and has since been rarely exceeded in locomotives of the same type and capacity.

8.—The design of this engine was based on the preceding example No. 7 and is due to the Indian Standards Committee. The outside dimensions of the boiler are identical, but the modifications in detail, the superheater equipment and fittings added from time to time have added more than 6 tons without a proportionate increase to the equivalent saturated heating surface. The tractive force is approximately the same as for No. 7.

9.—This design, based on the preceding example No. 8, represents the latest development of the Indian B.G. 2–8–0 type. Further modifications in the design of details, together with special fittings, including oil-burning apparatus, have added a further 2.3 tons to the weight, a total of 8.4 tons additional to the prototype No. 7. The cylinders are somewhat increased and the tractive force, but by no means proportionately to the increase in weight.

A consideration of the modifications which were subsequently made in Committee leads to examination of the writer's concluding argument, the harmful effect of

(3) MODIFICATIONS OR ADDITIONS TO A "BASIC" DESIGN, WHICH ADD TO THE WEIGHT WITHOUT A PROPORTIONATE INCREASE TO THE HEATING SURFACE.

The basic design referred to above has since passed through four stages, the first three at the hands of the Indian Standards Committee, the fourth to meet the requirements of a particular railway company. In addition to an elaboration of many details, these stages have involved (1) a lengthening of the wheel base; (2) the substitution of Walschaerts' for Stephenson's gear, and a drive on to the third axle, these stages together involving an increase in weight of about 4 tons, while the boiler remained as originally designed; (3) the addition of a superheater, giving some addition to the value of the heating surface by the equivalent of perhaps about 200ft. saturated

[5] See THE ENGINEER, Vol. CXXXV., January 5th, 1923, p. 4, and Supplement.

[6] See THE ENGINEER, Vol. CXXIX., p. 524.

[7] See *Railway Gazette*, March 7th, 1924, p. 318.

[8] See THE ENGINEER, November 6th, 1903, for drawings and description.

surface, but increasing the weight by a further 2 tons; (4) further considerable modifications to the engine in a recent design, though the boiler remains as before, have involved the addition of another 2¼ tons, with the result that an engine of the 2–8–0 type, having a boiler of precisely the same external dimensions as the basic engine built for the Bengal-Nagpur Railway in 1904, now weighs 75¼ tons, an increase of nearly 8½ tons.

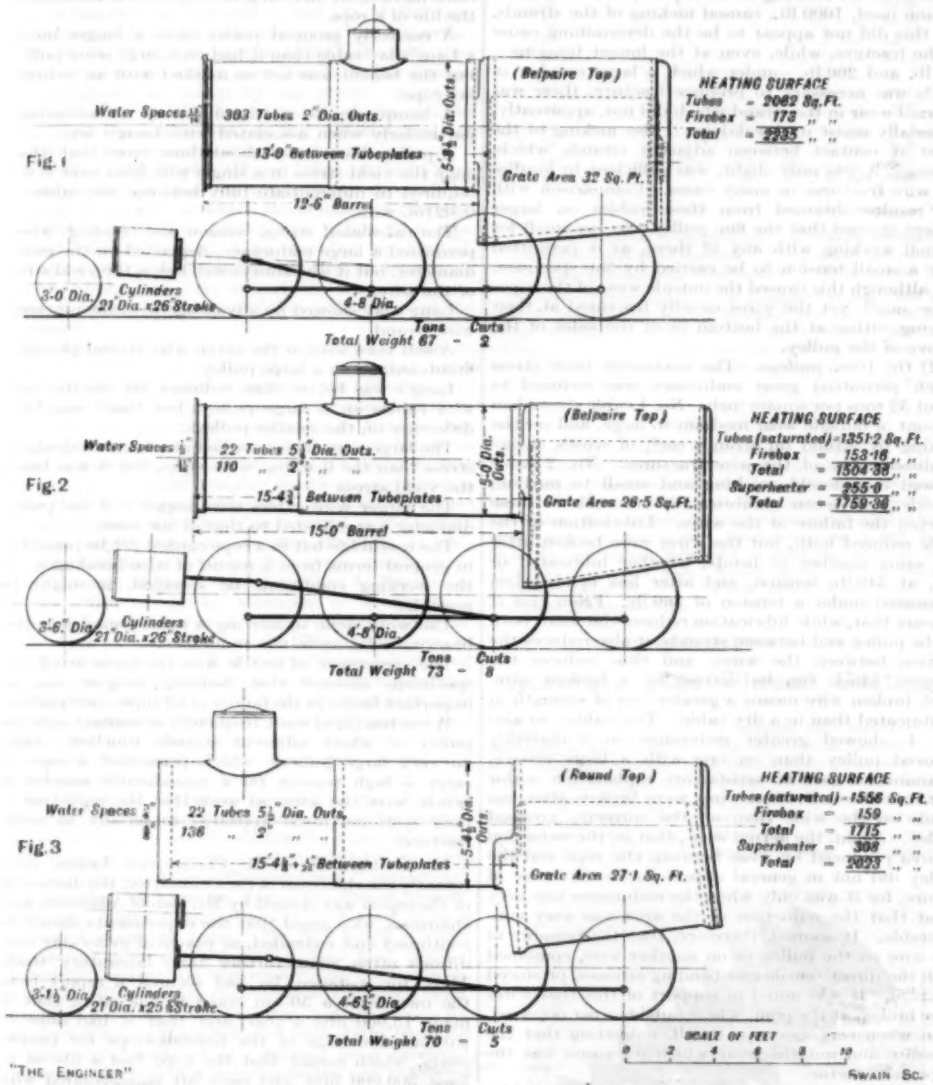
Against this weight we have to put some improvement in the driving gear, as, *e.g.*, a drive on to the third coupled axle, the use of piston valves, and also, in the last case, improved steam parts and valve gear, with the benefits derivable from superheating which, on the latest assumptions, may, however, be taken as considerably less than at one time claimed. It is noticeable, for instance, that there has been lately a marked return to the use of higher boiler pressures with superheat, and that the claim of benefit from decreased wear and tear of boiler therefore falls to the ground.

When we come to engine performance, is there any evidence that the additions made to the Indian standard 2–8–0 engine have given a return in proportion to the largely increased deadweight, not to mention the higher first cost and certain running costs which may be greater? How delightful and interesting an experiment might be made by taking an engine of the basic design, with all its faults, overlooking the "simplicity" which seems to have proved its undoing in committee, fitting it with perhaps 7 tons additional saturated boiler and trying it against its latest and more luxurious descendants! The lines on which such a comparison might be made will be suggested at the conclusion of this article, and they are submitted by the writer to the consideration of those chief mechanical engineers by whom alone they can be carried out under present conditions.

It is the fashion now to make, and such cases offer some justification for it, an unpleasant comparison of British with foreign design, but the other examples cited in this article and an intimate knowledge of the facts appear to the writer to support his contention that when given a free hand the British builders can produce to-day, as they have in the past, results as good as those obtained by their opposite numbers. British home railway design has not uniformly produced such good results, partly because the higher axle loads permitted on a superior permanent way have removed the incentive which still faces the designer for the continental and colonial lines, and, until recently, the Indian lines.

Fortunately for the credit of the home locomotive, these limitations are being felt more severely with ever-increasing demands for power, and the home railways have produced some admirable designs in recent years, approaching the results obtained long ago by the builders in respect of the ratio power/weight. These may help the steam locomotive to survive the coming attack, of which there have been unmistakable signs in the political world and popular Press. Certainly, if it is to stand up to the criticism, whether of those politicians who would prove it to be the source of all our present railway difficulties, or of those who think of the steam locomotive only in terms of thermal efficiency, it must at least shed its useless deadweight.

Speaking before the Institution of Civil Engineers in 1884, such an authority as Thornycroft could say that when he commenced building high-speed engines he had taken the locomotive engine for his model. It still remains a model, if its efficiency can be preserved by simplicity rather than by an infinite complication of parts and the elaboration of fittings. A return to such simplicity is the hope of many who do not wish to see the steam locomotive quoted—with the pheasant—as one of its country's worst enemies, and who do not accept the imputation that the British builders have forgotten the rudiments of their art. It was they who nursed the locomotive through infancy, and it has been largely due to them that it has since been protected from some of the diseases—or "complications"—which from time to time have threatened rather than increased its usefulness, only eventually to swell the scrap heaps of the repair shops.



COMPARISON OF LOCOMOTIVES

SUPERHEATING.

Some railway running men to-day are asking themselves whether superheating is invariably worth while. Possibly there may be no other way yet discovered for increasing the power or improving the thermal efficiency of a locomotive, whose boiler dimensions have reached the maximum permitted by the load gauge; but there are many thousands of engines of medium size in this country, of the 0–6–0 and 4–4–0, or even of the earlier 4–6–0 types, whose power it is desired to increase, and whose boilers might easily be increased in dimensions so that they might still be operated with saturated steam, though more economically than before.

It is, indeed, open to question whether a really fair trial has yet been made in this country, at any rate, between a saturated and a superheated engine, otherwise of the same class and of the same weight. Many results have been published[9] of trials between engines of the 4–4–0 and 0–6–0 types respectively, the competitors being, on the one hand, as originally designed for saturated steam; on the other, as fitted with a superheater, involving the addition of about 2 tons to the weight. The results of the trials usually show not only reduction of fuel consumption in the superheated engine, but also an increased performance. No one, within the writer's recollection, has yet asked whether some of these better results might not be obtained by improving the saturated engine within the limits of a like addition of 2 tons to its weight, which, it if does nothing else, gives a better factor of adhesion. In addition, there is, of course, the thermal gain from superheating, due partly to—(*a*) the greater extraction of heat from the products of combustion, which is probably proportionately more when the superheater is fitted to a boiler having a comparatively short barrel; (*b*) the lower rate of fuel combustion per square foot of grate; (*c*) the better evaporation per square foot of heating surface of the large diameter tubes required for the superheater elements; (*d*) the better water circulation and freer steaming due to the reduction in the number of tubes.

Now, if the 2 tons increased weight allowed to the superheated engine were to be credited to the saturated engine in the form of a larger boiler, with larger grate, improved water spaces, larger—and in many cases longer—tubes, we might see an experiment as well worth while as many that are being carried out to-day. It is quite possible that the lines of fuel economy might converge to a point at which some revision of accepted conclusions would be required and a return to simplicity amply justified at least for locomotives of moderate power.

Institution of Mechanical Engineers

WIRE ROPES.

THE first report of the Committee set up by the Institution of Mechanical Engineers to investigate the strength of wire ropes, which was published in 1920, indicated that there was a wide divergence of opinion on the subject, and it was then decided that it would be desirable for some further experiments to be carried out with the idea of establishing more definite data on which specifications for wire ropes could be based.

On Friday, the 19th inst., the second report of the Committee was submitted to the Institution by Dr. W. A. Scoble, of Woolwich, but it really appears that more extensive experimentation will be necessary if the results are to be accepted as authoritative.

In view of the limitations of the resources of the Committee, the investigations were confined to ropes not larger than 1in. in circumference, and Messrs. Bullivant presented several samples within that size for test purposes. The uniform quality of material adopted was specified as "special acid patent steel" of 70 to 80 tons per square inch ultimate tensile strength, and it was used in wire of two diameters—(*a*) 0.021in., with an analysis C 0.36, Mn 0.605, S 0.042, Si 0.240, P 0.053 per cent., specially obtained in two bundles from the mills; and (*b*) 0.036in. from the ropemaker's stock.

There were, in all, eight distinct types of rope, in two separate groups. One group was made from wire 0.021in. in diameter and the other from 0.036in. wire. All the ropes had six strands, each of which was built up of from six to twelve wires. Some were of Lang's lay and some were ordinary lay. The descriptions of the ropes are given as follows in the paper.

No. 1	6 × 12 × 0.021	Lang's lay	Strand of 12 wires round hemp core
No. 2	6 × 12 × 0.021	Ordinary lay	Ditto
No. 3	6 × 19 × 0.021	Lang's lay	Strand of 12 over 6 over 1
No. 4	6 × 19 × 0.021	Ordinarylay	Ditto
No. 6	6 × 6 × 0.036	Lang's lay	Strand of 6 × 0.036 on core wire of 0.038 iron
No. 7	6 × 7 × 0.036	Lang's lay	Strand of 6 on 1, all 0.036
No. 8	6 × 7 × 0.036	Ordinary lay	Ditto

These ropes were tested in groups in a machine which comprised a set of pairs of pulleys, or sheaves, in a frame. Each sample of rope was rove round a pair of pulleys, of which the larger one was oscillated so as to give the rope a to-and-fro motion over the smaller, test, pulley. The tension on the rope was adjusted by means of a long screw and spring, and the number of cycles through which the rope would pass before failure was recorded. The size of the test pulleys was altered from time to time, in order to determine the effect of their diameter on the endurance of the rope.

The preliminary tests were carried out on single wires and a million bends were taken as the limit of endurance, as it was considered to be of a practicable value. It was estimated that a wire of the size being tested, 0.021in. in diameter, would be stressed to its

[9] (*a*) Fowler on "Superheating in Locomotives." "Proc.," Inst. C.E., 1913–14. Vol. CXCVI. (*b*) Hughes on "Compounding and Superheating in Horwich Locomotives." "Proc.," Inst. M.E., 1910 No. 2.

yield point when bent over a pulley 4.7in. in diameter. On smaller pulleys the number of bends required to produce fracture was less than 100,000, and on 5in. and 6in. pulleys the numbers of bends were of this order when the calculated stress was in the region of the yield stress of the material. Contrary to expectations, it was found that at greater tensions an increased number of bends was necessary to produce fracture. Possibly the added tension, beyond that which caused yield, produced a more favourable stress range which would account for this apparent anomaly. On pulleys of 7.5in. and 10in. diameter, the wire showed great endurance, the number of bends before failure being over a million, and in these cases also the tension produced no marked effect, although so high that yield must have been produced.

When the experiments were extended to include stranded wires, the peculiarity just referred to did not reappear, and in each case the tension carried by a strand for a given number of bends was greater on a large pulley than was the case with one of smaller diameter, while the number of bends required to produce fracture on a given pulley increased as the tension was diminished.

After the separate strands had been tested the completed cables were put on the machines and were tested at tension stresses which were calculated by dividing the total tension in the rope by the cross-sectional areas of the wires forming it, and the bending stress from the formula $E\,d/D$, where E = Young's modulus, d = diameter of the wire, and D = diameter of the pulley. Some of the results of this series of tests are given in the table below :—

Repeated Bending of Wire Ropes Over Pulleys.

Cable 6 × 12 × 0.021in., 84 tons per square inch. Hemp cores to strand and rope. Black wire. Lang's lay. Lay wire 1.1in. Strand 2.67in.

Pulley diameter.	Cable tension.	Bends to failure.	Method of failure.	Stress due to tension.	Bending stress $E\,d/D$.
Inches.	Lb.			T. per sq. in.	T. per sq. in.
6 grooved	720	60,206	Not carry load	12.9	44.3
,,	540	94,887	,,	9.7	,,
,,	1000 (oiled)	51,133	Broken	17.9	,,
,,	288	221,142	Not carry load	5.16	,,
10 ,,	1000	272,608	Not carry load	17.9	27.2
,,	540	575,301	,,	9.7	,,
14 ,,	2240	94,077	Broken	40.0	19.6
,,	1500	460,125	,,	26.9	,,
,,	1000	1,181,190	,,	17.9	,,
,,	1500 (lubricated)	216,800	,,	26.9	,,
18.5 ,,	2240 (inbricated)	508,825	,,	40.0	14.9

Cable 6 × 12 × 0.021in., 84 tons per square inch. Hemp cores to strands and rope. Black wire. Ordinary lay. Lay of strand 2.33in.

*10grooved	540	395,322	Not carry load	9.7	27.2
* ,,	360	885,561	Broken	6.45	,,
†6 ,,	360	143,486	Broken	6.45	44.3
† ,,	216	224,287	Not carry load	3.9	,,
,,	100	1,125,872	Not broken	1.8	,,
10 ,,	720	148,431	Broken	12.9	27.2
,,	540	190,513	Broken	9.7	27.2
,,	360	531,327	,,	6.45	,,
14 ,,	1680	32,700	,,	30.1	19.6
,,	720	413,460	,,	12.9	,,
,,	600	529,849	Not carry load	10.7	,,
,,	450	1,031,762	Not broken	8.1	,,

* Specimens not oiled.

† For all tests below, specimens oiled, pulleys grooved to fit rope.

Cable 6 × 7 × 0.036in., 85 tons per square inch. Hemp core to rope. Black wire. Lang's lay. Lay of strand 2.65in.

10 grooved	1120	105,895	Broken	11.7	48.2
,,	600	225,583	,,	6.25	,,
,,	350	490,212	,,	3.65	,,
,,	200	1,019,617	,,	2.1	,,
13.5 ,,	1120	194,338	,,	11.7	35.7
,,	840	491,162	,,	8.8	,,
,,	700	797,179	,,	7.3	,,
17.5 ,,	2240	747,305	Not carry load	23.4	27.55
,,	2800	250,142	Broken	29.25	,,

Cable 6 × 7 × 0.036in., 85 tons per square inch. Hemp core to rope. Black wire. Ordinary lay. Lay of strand 2.36in.

10 grooved	1120	89,408	Broken	11.7	48.2
,,	420	343,970	,,	4.4	,,
,,	350	655,593	,,	3.65	,,
14.65 ,,	1120	291,149	,,	11.7	32.9
,,	900	532,876	,,	9.4	,,
,,	750	1,040,600	Not broken	7.8	,,
17.5 ,,	2240	128,833	Broken	23.4	27.55
,,	1680	367,395	Not carry load	17.5	,,
,,	1500	296,083	Broken	15.65	,,
,,	1200	318,273	,,	12.5	,,

On comparing the results of the performances of the cables built up of 0.021in. wires with those of 0.036in. wires, which represents an increase of approximately three times in the sectional area of each wire, it is observable that on the 14in. pulleys the large wire cables were superior to small wire cables under long endurance conditions, while on pulleys having a diameter suitable for the wire diameter, they were immensely so. The large wire cables failed rather badly on 10in. pulleys, thus giving an indication that the critical diameter for cables of 0.036in. wire is in the region of 14in.

One of the most remarkable results of these tests, which is quite contrary to the remarks made in the previous report of the Committee, is that there may be occasions when the lubrication of a rope will actually reduce its endurance.

Reviewing the results obtained during the tests, the report goes on as follows with regard to small cables :—

(1) *On Small Pulleys, 6in. Diameter.*—The calculated maximum stress, that is, direct tensile stress plus the full stress due to bending, was from 46 to 48 tons per square inch, which is well below the yield stress in simple tension. Although the relative movements of the strands was greater on smaller than on larger pulleys, the nicking caused by one strand on another was small to negligible in cables 1, 2 and 3, and 4 alone showed appreciable effects of the internal working of the rope. Here the highest tension used, 1000 lb., caused nicking of the strands, but this did not appear to be the determining cause of the fracture, while, even at the lowest tensions—250 lb. and 200 lb.—under which a large number of bends was necessary to produce fracture, there was internal wear in the strand which did not, apparently, materially assist its breakdown ; also nicking of the wires at contact between adjacent strands which, although it was only slight, was sufficient to localise the wire fractures in many cases. Comparison with the results obtained from these cables on larger pulleys showed that the 6in. pulley was too small for normal working with any of them, as it permitted only a small tension to be carried by the specimen, and although this caused the outside wear of the ropes to be small, yet the wires usually fractured at their bearing, either at the bottom or at the sides of the groove of the pulley.

(2) *On 10in. pulleys.*—The maximum total stress which permitted great endurance was reduced to about 32 tons per square inch. No. 1 cable showed an amount of outside wear medium to large, and serious nicking by strand on strand, each of which causes localised many of the wire fractures. No. 2 cable showed considerable nicking and small to medium outside wear when unlubricated, but each of these effected the failure of the wires. Lubrication of the cable reduced both, but the wires were broken after the same number of bends, whether lubricated or dry, at 540 lb. tension, and after less bends when lubricated under a tension of 360 lb. From this it appears that, while lubrication reduces the wear, both at the pulley and between strands, it also reduces the friction between the wires, and thus reduces the tension, which can be carried by a broken wire. Each broken wire means a greater loss of strength in a lubricated than in a dry cable. This cable—as also No. 1—showed greater endurance on a correctly grooved pulley than on one with a large groove. Examination gave no satisfactory explanation of this fact, but the individual wires were broken after less bends on the wide than on the correctly grooved pulley. Again, the actual wear, that is, the reduction of area produced by wear between the rope and the pulley did not in general appear to be the cause of failure, for it was only when the endurance was very great that the reduction of the area was very considerable. It seemed, therefore, that the pressure of the wire on the pulley or on another wire, combined with the direct tensile and bending stresses, produced fracture. It was noted in support of this that wires were broken at the point where outside wear occurred, even when this wear was small, indicating that the pressure and not the wear which it caused was the important factor.

(3) *On 14in. Pulleys.*—The wear of the wires was considerable in cable No. 1, which was apparently weakened by this cause, but no such result was noticed in cables Nos. 2, 3 and 4.

Maximum Tensile Stress Carried.—Cable No. 1 was superior in this respect to the other three, which were approximately equal. It will be observed that this feature increased with the increase of size of pulley, for, whereas all the cables showed about equal performances on the 6in. pulley, which was too small, No. 1 showed some superiority on the 10in. pulley.

Effect of Lay.—The cable of Lang's lay, with a fibre core to the strand, gave the best results on the large pulley, although, exceptionally, the nineteen-wire strand of this lay showed no superiority over one of ordinary lay.

In connection with the tests of thick wire cables on 10in. pulleys, the following remarks are made :—The maximum tensile stresses for the three cables were nearly equal at approximately 51 tons per square inch—(*a*) the soft wire core did not apparently improve the cable ; (*b*) Lang's lay did not appear to be superior to the ordinary lay.

Wear of Wires.—The nicking of strand on strand was negligible, probably because the tensions used were very small indeed. Outside wear was small or medium for cables Nos. 6 and 7, and less for cable No. 8, although this was the only rope on which it localised the fractures of the wires. This indicates that the maximum tensile stresses for the Lang's lay cables were below the yield stresses owing to an unequal distribution of tension among the wires when the cable was bent over the pulley, or that at low tensions on small pulleys the cable does not bed properly in the groove, and thus secure the full benefit of the longer bearing which Lang's lay should give.

After describing tests made on the physical characteristics of single wires, the report gives the following summary :—

Summary.—Single wires tested by repeated bending over pulleys gave unexpected results, standing more bends under greater tension.

The calculated stresses in strands, at which they endured a million bends, were, taking the full bending stress, 58 tons per square inch for 12 by 0.021 on hemp core, 49 tons per square inch for 6 on 1, and 45 tons per square inch for nineteen wires, 12 on 6 on 1. The yield stress of the wire was 64 tons per square inch. From this it appears that the bearing pressure between the wire and pulley is important in the case of strands.

Lubrication of a cable was slightly beneficial in one case when the conditions were severe and the cable had a short life, but generally lubrication reduced the life of a rope.

A correctly grooved pulley gave a longer life to a Lang's lay cable than it had on a large score pulley, but the benefit was not so marked with an ordinary lay rope.

A hemp core to a strand proved an advantage, particularly when associated with Lang's lay.

A pulley diameter of about three times that which gave the yield stress in a single wire bent over it was required to differentiate fully between the cables of 0.021in. wire.

The calculated stress, tension and bending, which permitted a large endurance, depended on the pulley diameter, but it was always well below the yield stress of the wire.

Lang's lay showed no advantage with the nineteen-wire strand.

A soft core wire in the seven-wire strand proved a disadvantage on a large pulley.

Lang's was better than ordinary lay for the large wire cables on a large pulley, but there was little difference on the smaller pulleys.

The large wire cables worked at a higher calculated stress than the 0.021in. wire ropes, but it was below the yield stress.

The larger wire cables were superior if the pulley diameter was adjusted to that of the wire.

The useful life left in a rope cannot yet be predicted in general terms from a record of wire breakages. If the working conditions be specified, it might be possible.

The work done in moving a cable round a pulley bears no relation to the endurance.

The occurrence of brittle wire fractures in all test specimens showed that bending fatigue was an important factor in the failure of all ropes over pulleys.

Wires fractured most frequently at contact with the pulley or where adjacent strands touched. Only on very large pulleys, which permitted a rope to carry a high tension for a considerable number of bends, were the wires so worn that the reduction of their sectional areas appeared materially to assist fracture.

In the absence of Mr. Christopher James, until recently the chairman of the Committee, the discussion of the report was opened by Mr. Daniel Adamson, now chairman, who urged that the experiments should be continued and extended, as practical every-day conditions often went further than laboratory trials. Thus, for instance, he had secured a report from the owners of a 30-ton crane to the effect that it made 15,000 lifts a year, and that it had done so without a change of the hoisting rope for twenty years, which meant that the rope had a life of at least 300,000 lifts, and each lift corresponded with more than one bend under load. He could not agree with Dr. Scoble that pulleys as small as 6in. in diameter were too small for the ropes tested, as pulleys of that size were commonly used for such ropes, while 8in. diameter was considered a generous proportion. Mr. Adamson said that he would like to have a definition as to when a rope should be condemned as being unsafe, and pointed out in that connection that the curves given in the report showed some very wide open regions in which the behaviour of the ropes was left undecided. It should be remembered, however, that the conditions met in ordinary workshop practice were also very variable, and covered a wide range. It had, he said, been previously suggested that an increase in the diameter of a pulley over which a wire rope worked, by two rope circumferences, doubled the life of the rope. Using this basis, and assuming that the life of the rope followed a hyperbolic law, he had drawn curves which he had superimposed on those given in the report. Mr. Adamson exhibited his curves, by means of a lantern slide, and the agreement with Dr. Scoble's results was quite noteworthy. As demonstrating the effect on the life of a cable by bending it when under load, Mr. Adamson mentioned the case of a lift at the Municipal College of Technology, Belfast, where an alteration of the arrangement which reduced the number of bends from seven to two increased the life of the rope from 1¾ year to 7 years. On the other hand, he said that it had been established, in connection with the lifts in the Eiffel Tower, that it was

as detrimental to a cable to bend it through an angle of 20 deg. as through 180 deg.

Mr. Robert Armitage spoke from the point of view of a user of steel wire ropes for colliery work, but mentioned that he also saw a good deal of the manufacture of the steel for wire. He held that the failure of ropes was frequently due to defects in the wire, and he showed by sulphur prints thrown on the screen how "piping" in the original ingot might be carried right through to the finished wire, in which it produced a series of minute defects, called "cups." He held also that damage to the steel by "teeming" at too high a temperature might be handed down to the wire.

Mr. Woodfield commented on the uncertain character of wire ropes, two pieces of which, taken from the same coil, might be quite different. He could not understand the result, arrived at in the report, that lubrication might be detrimental to a rope, as lubrication had been well established as necessary by practical experience. He also knew of a case where altering the lead of a rope had greatly increased its life. It was in the case of a large crane in the City. By altering the position of the crab, so that two out of four bends were eliminated, the life of the rope was increased from 3 to 5 weeks up to 7 or 8 months.

Mr. C. H. Wingfield suggested that the fact that single wires would stand more bends as the tension was increased, as shown by the report, might be accounted for by the displacement of the neutral axis, from the centre line, as the material was not equally strong in tension and compression.

Mr. Stevenson Taylor (Home Office) thought that it was important that the experiments should take account of the rate at which the bending of the rope was effected. In his opinion, the failure of a rope started gradually, and then rapidly accelerated, and the point of acceleration afforded an idea as to the life of the rope. As soon as the wires in a rope began to break, the frequency of inspections should be increased.

Mr. Lloyd, of the Whitecross Company, pointed out, in connection with the phenomenon, that wires would bear additional bends as the tension was increased, that the elastic limit of the steel would be about 65 tons per square inch when in tension, but in compression it would be less than two-thirds as much. Moreover, a perfectly straight piece of wire was known to exhibit a higher tensile strength than a piece that was slightly crooked. He suggested that the acceleration of the rope, on reversal, in the testing machine might have considerable effect on its ultimate failure, and explained that ropes usually fractured through the steel being hardened to Martensite by the effect of shocks, vibration or acceleration. Mr. Lloyd thought that it would be profitable if the trials were extended to include larger ropes, say, of 2in. circumference, as it did not always follow that an increase in size produced a corresponding increase in strength. Ropes built up with the American style of lay, in which all the wires were laid parallel and consequently had line contact with one another, with the result that nicking was eliminated, might also be included.

Mr. Hines, of Rylands, Limited, urged that the investigations of the Committee should be started earlier in the process of making the rope, and that each stage should be explored separately, as there were so many variables. The process of "patenting," or tempering, for instance, was of the utmost importance, and might change the life of a rope from a matter of weeks to years. He had found it more satisfactory to test ropes with a dead load, instead of springs, and to run the rope round continuously in one direction, rather than reverse it for each bend. He suggested that it was possible that the reason for the shorter life of the lubricated rope might be found in the displacement of the original good lubricant on the wire by one of inferior qualities, and exhibited a slide which showed how the outer part of a wire after long service had been converted to Martensite.

Mr. Stevens emphasised the value of avoiding guide pulleys in increasing the life of a rope, and Dr. Scoble replied briefly, remarking that mining was practically the only industry in which pulleys large enough for the ropes were habitually used.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

SALARIES OF ENGINEERS.

Sir,—In your issue of the 12th inst. you published an advertisement, from the Royal Aircraft establishment at Farnborough, who want an assistant engineer with the qualifications of a University degree and works and drawing-office experience, offering to such a man a salary of £3 a week, plus Civil Service bonus.

It must come as a shock to the engineering profession that this is what the Government has to offer in the way of salary to a highly trained and experienced member of that profession. We have taken the matter up with the Air Ministry, and have drawn the attention of the Institution of Aeronautical Engineers and the Royal Aeronautical Society to it.

Ordinarily the two last-mentioned bodies do not, we understand, concern themselves with salary questions, but the action of the Air Ministry is so derogatory to the standing of the profession that we think all bodies having the interests of engineering at heart would do well to indicate to the Government their opinion of the deplorable action of the Air Ministry.

R. Hazleton, Secretary,
London, December 19th. Society of Technical Engineers.

PRESSURE DROP TO STEAM CHEST IN LOCOMOTIVES.

Sir,—In this connection the following figures may be of some interest; they represent the values obtained when taking more than 400 indicator diagrams on a superheater locomotive developing up to 1200 indicated horse-power when working express passenger trains on the London-Scotland traffic some years ago. The diagrams were nearly all taken under regular working conditions, and usually no instructions whatever were given to the driver, as the object was to obtain results as close to the normal average as possible. In many cases the diagrams were taken every two miles, irrespective of the speed or any other working conditions, so that I believe the results show very fairly the normal running conditions. I think I have somewhere records of saturated engines, but they are not readily available, nor have they been analysed in this manner.

Pressure drop. Lb. per sq. in.	Per cent. of diagrams.
0	4.0
5	11.5
10	15.9
15	15.9
20	15.2
25	12.7
30	11.7
35	8.0
40	3.3
45	0.3
50	0.8
55	0.2
60	0.5
	100.0

Nominal working boiler pressure	200 lb. per sq. in.
Actual average boiler pressure	192 lb. per sq. in.
Average pressure drop to steam chest	17 lb. per sq. in.

The above figures represent the average of at least 2000 miles express passenger working in England, and their value is of, course, different from that of test bench results. The larger values of the pressure drop naturally refer to the cases where the engine was running at speed on first regulator.

Glasgow, December 16th. P. H. Parr.

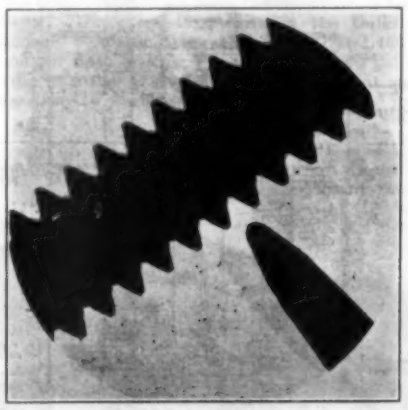
MONEL METAL.

Sir,—Our attention has been called to the table on page 606 of your issue of November 28th, 1924,* which professes to give the physical properties of Monel metal. May we point out, for the benefit of your readers, that these figures are incorrect and misleading. For example, the ultimate tensile strength of forged Monel metal at atmospheric temperatures is 85,000 lb. to 90,000 lb. per square inch, and at 1000 deg. Fah. is about 55,000 lb. per square inch. Brinell figures for this material range from 150 to 190.

For G. and J. Weir, Ltd.,
Glasgow, December 17th. W. J. Anstey.

Accurate Fine Thread Cutting.

The accuracy possible by present-day machine shop methods is illustrated by the illustration herewith. It is an enlargement magnified twenty-four times of a screw 1 mm. diameter by .25 mm. pitch S.I. form of thread, and for comparison purposes the point of an ordinary pin is placed alongside. This screw was cut by ordinary commercial methods, using a set of dies in a ¾in. Coventry diehead, mounted on a No. 4 capstan lathe. The dies were



ENLARGEMENT OF SCREW THREAD 1 MM. DIAMETER

produced by the same standard method as is used for threads of coarser pitches. In addition to the machining operations involved in the production of the thread, the chaser, the hob and the dies had to be hardened.

As can be seen by the illustration, the form of thread is quite good and the pitch of the sample photographed, which is approximately 102 threads per inch, is, we are informed by Alfred Herbert, Limited, correct within .003in. per inch. The whole depth of the thread is .0069in. The hob used for cutting the dies was correct in pitch after hardening to within .0005in. per inch.

The Government of Argentina has ordered from America 38,000 tons of galvanised steel sheets for a barrier against the invasion of locusts.

*Quoted from a communication by the Chapman Valve Manufacturing Company.—Ed. The E.

The Jharia Waterworks.

The Jharia coalfield is the most important coal-mining area in India. It is situated in the Manbhum district of the province of Behar and Orissa, about 160 miles from Calcutta, on the Grand Chord line of the East Indian Railway, which is the direct route between Calcutta and Bombay. The outcrop of workable coal covers an area about 20 miles long by 5 miles wide. The population to be supplied with water from the works described in this article averages at present about 150,000, but is subject to considerable seasonal fluctuations. The worker in an Indian coal mine is frequently an agriculturalist as well as a miner, and when the period of the year arrives when the fields require labour, either for sowing or gathering the crops, there is a considerable exodus from the colliery districts, with a corresponding return migration when the slack time in agriculture commences. The increase in population between the census of 1911 and that of 1921 was about 30,000, which, considering the prosperity of the Indian coal-mining industry during the war, was less than might have been expected.

The annual coal raisings from the mines in the Jharia area are about 8,000,000 tons. The average amount of coal worked per head of the working population—which frequently includes both male and female members of the same family—is about 100 tons per annum.

There has been at times much scarcity of water in this district, which in the case of some of the larger collieries has been met by filtering the water pumped from the mines, and distributing it over the property of the company concerned. These supplies are, however, not above suspicion on the score of quality, and there are many collieries, as well as the bazaars, which have had no supply except from tanks or wells. There have been several cholera epidemics in the past, some of them of a serious nature.

In 1909 the Indian Mining Association decided that a public water supply in the district was a matter of serious urgency, and at its request a firm of mechanical engineers in Calcutta put forward proposals for pumping a supply of 3,000,000 gallons a day from the river Damodar, which runs through the coalfield. The Jharia district at that time formed part of the province of Bengal, and the provincial Government formed a committee to consider this proposal. Before the committee met, the then Sanitary Commissioner, Major (now Lieut.-Colonel) Clemesha, I.M.S., and Mr. G. Bransby Williams, M. Inst. C.E., Sanitary Engineer, Bengal (now Chief Engineer, Public Health Department, Bengal), were asked to examine the project on the ground. Whilst motoring through the district, Mr. Williams was struck with the apparent suitability of a range of hills to the north-east of the coalfields for a catchment area and impounding reservoir, and, in the note on the scheme submitted to Government by the deputed officers, it was recommended that he should prepare alternative projects for (*a*) a gravitation supply from these hills, and (*b*) for a supply by pumping from the river. This recommendation was accepted, and Mr. Williams undertook the necessary investigations. After an examination of a number of dam sites, he decided that the most suitable position for an impounding reservoir would be in the valley lying between 3 and 4 miles to the south-east of the mountain of Parasnath, which rises to a height of 4500ft. above sea level, and is the highest mountain in Eastern India between the Himalayas and the Deccan plateau.

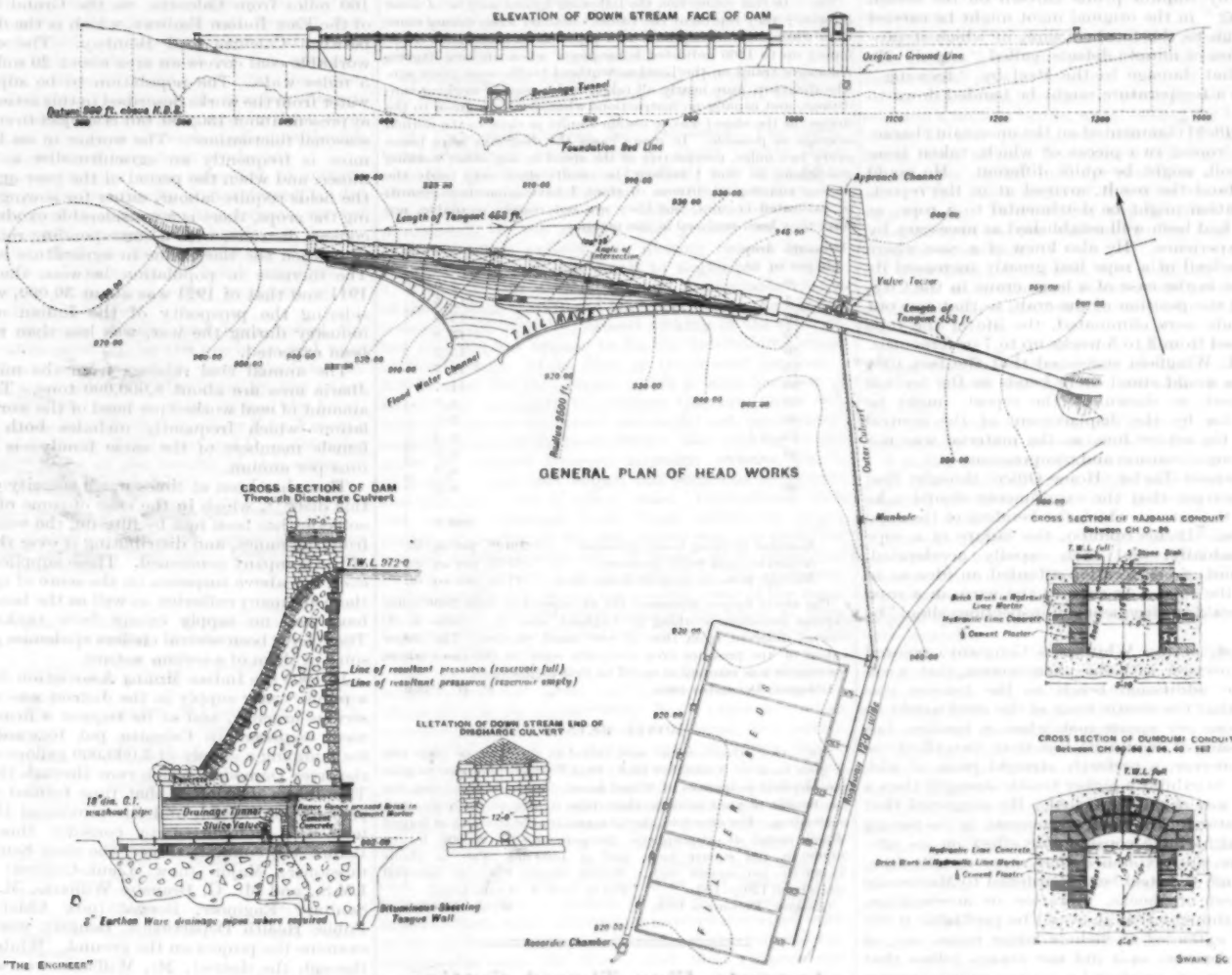
A survey of the reservoir site and the aqueduct line into the coalfields, as well as the distribution mains in the area of supply, was made, and Mr. Williams, in his report submitted in March, 1911, compared the cost of the scheme with one for pumping the same quantity of water from the Damodar, and recommended the former project as the more satisfactory of the two. Mr. Williams' report was referred to the Investigating Committee, but the latter remained in a state of suspended animation until the upheaval which attended the administrative changes by which the Government of India celebrated his Majesty's visit to India at the end of 1911. In April, 1912, the Jharia coalfield passed into the new-created province of Behar and Orissa. The water supply scheme was revived by Mr. (now Sir) L. Kershaw, who, in the capacity of Secretary to Government, reconstituted the Investigating Committee, and then, as Commissioner of the Chota Nagpur Division, presided over it himself. Under his energetic guidance, the Committee was not long in arriving at a decision. The gravitation scheme was recommended, but the area of supply, and consequently the amount of the estimate, were reduced by omitting from the proposed area of supply Dhanbad, which is a town just outside the coalfield, but which is the headquarters of the subdivision and an important railway centre.

The Government of Behar and Orissa accepted the recommendations of the Committee. Mr. Williams was appointed Consulting Engineer for the undertaking, and was asked to draw up a detailed scheme on the lines of his previous project. This was completed in 1913. The Government of Behar and Orissa, before finally accepting it, submitted it for general criticism to the late Sir Alexander Binnie, Past-President, Inst. C.E., who approved of it, subject to

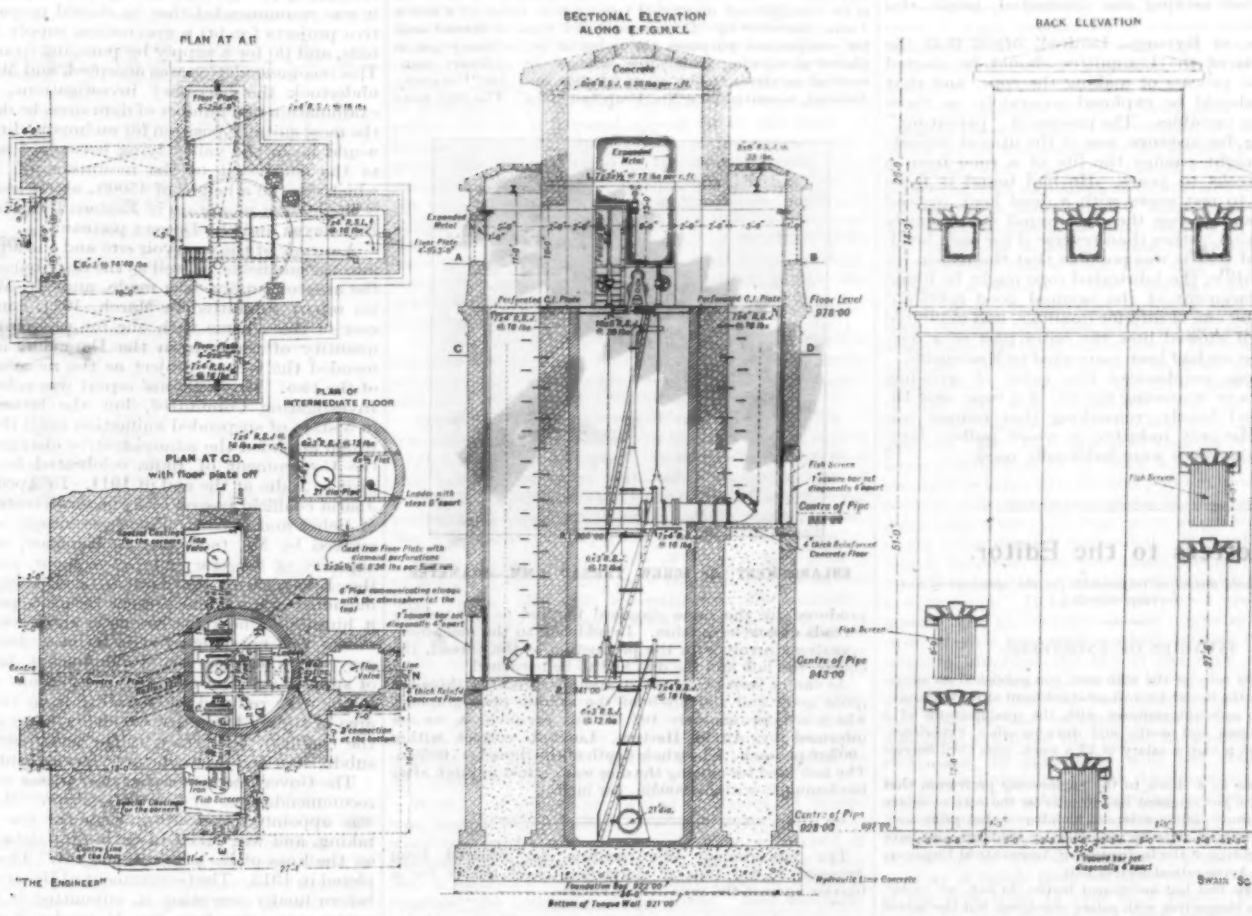
WATERWORKS FOR THE JHARIA COALFIELD, INDIA

MR. G. BRANSBY WILLIAMS, M. Inst. C.E., CALCUTTA, ENGINEER

(*For description see opposite page*)



PLAN OF HEAD WORKS, SECTION OF DAM, AND TYPICAL SECTIONS OF CONDUIT



ARRANGEMENT OF THE VALVE TOWER

a few alterations in the details. An Act was passed through the Behar and Orissa Legislative Council in the session of 1913–14 constituting a Water Board, and giving the Board powers to carry out the works and levy the cess on tonnage and charges for water that were necessary for the financing of the scheme. Work was commenced early in 1915.

The scheme as sanctioned provided for a population of 200,000 persons with 12 gallons per head per day. As the water is to be for domestic consumption only, almost the whole of that consumed will be drawn to augment the supply it will be only necessary to lay a second line of pipes alongside the first.

It eventually appeared, when the census returns of 1921 were available, that the scare was unfounded, and that the increase in the population left a large margin below the estimated maximum, on the basis of which the scheme had been drawn up. On the other hand, the records of rainfall and run off show that although the mean annual rainfall is more than Mr. Williams' estimate, and is over 60in., the quantity that can be relied on during the three driest years

FIG. 1 MAP SHOWING THE CATCHMENT AREA, THE PIPE LINE AND THE JHARIA COALFIELD

through outside stand-posts and taps, and as there is no prospect of a water-carriage sewerage system, this appeared to be an ample provision. The position of the catchment area and site of the reservoir, the line of the aqueduct, and the main distribution pipes in the coalfields, will be seen from the general plan—Fig. 1. The direct catchment area of the lake is 2543 acres and a subsidiary catchment area of 522 acres has been tapped by a catchwater channel, making the total 3065 acres. Mr. Williams originally estimated the mean annual rainfall at 59in., and the run off, collectable in the three driest consecutive years, 18in. On this basis of calculation the yield would be 3,430,000 gallons per day from the catchment area included in the scheme.

After the work had been in progress for some time a scare arose as to the sufficiency of the supply. It was believed locally that the population of the coalfield had increased so much that the estimated maximum population of 200,000 had already been largely exceeded. The question of increasing the capacity of the lake and extending the catchment area was therefore considered. The construction of the dam had not proceeded so far that an alteration of its profile could not be made. As originally designed the inner face had a batter. By changing this to a vertical face it was found that the height could be increased by 4ft. without appreciably adding to the maximum pressure intensity—about 6¼ tons per square foot—and that the line of resultant pressures would still be well within the middle third of the dam. This change in the design was made and the capacity of the reservoir was increased thereby from 950,000,000 gallons to 1,150,000,000 gallons. At the same time it was arranged to tap a third catchment area of 1700 acres, lying immediately to the south-east of Paresnath Mountain, by a conduit which follows the contour of the hillside between the reservoir and the stream at Dalkhutta, where the latter emerges from the gorge through which it flows down from the mountains. The size of the main conduit was also increased, making its capacity 4,000,000 gallons per day. The pipes on the syphon were left as originally designed, of a size to discharge 2,400,000 gallons per day. If it becomes desirable is less than his figure, being not more than 14in. The yield of the 3065 acres in the original scheme cannot, therefore, be put at more than 2,670,000 gallons per day, which, when allowance is made for loss from evaporation from the reservoir, is barely sufficient. The extra 1700 acres in the Dalkhutta catchment area increases the yield by 1,480,000 gallons per day, making the total 4,150,000 gallons. In order to utilise the whole of this volume, it would be necessary to construct a second impounding reservoir in the Dalkhutta valley to hold about 350,000,000 gallons. As the scheme now stands, however, it is much more elastic than the original one and provides an ample reserve for future extension if required.

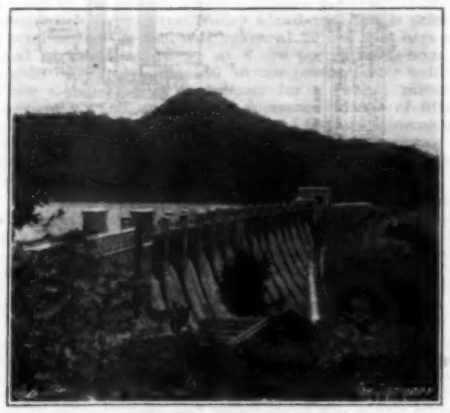


FIG. 2—GENERAL VIEW OF DAM FROM THE WEST

The dam and headworks are illustrated on page 722 and in the half-tone engravings—Figs. 2, 3 and 4—the cross section of the dam being shown in the upper drawing on page 722. The hearting is composed of the local gneiss, which has a weight of about 192 lb. per cubic foot, a crushing strength of 1100 tons per square foot and an absorption of 0.9 per cwt. The face stone is Katras stone, a light coloured sandstone which has a weight of 158 lb. per cubic foot, a crushing strength of 275 tons per square foot and an absorption of 2.4 per cwt. The whole of the masonry work is in a mortar composed of hydraulic lime, made by burning and grinding kunkar in kilns at the works site and Damodar sand. The tensile strength eventually developed by this mortar is something over half that of Portand cement mortar containing the same proportion of sand. The face stone is rock faced block-in-course work. The joints in both the inner and outer faces were all raked out to a depth of 2in. and caulked with cement mortar. The hearting masonry is composed of "plums" set in the mortar. Spalls were rammed

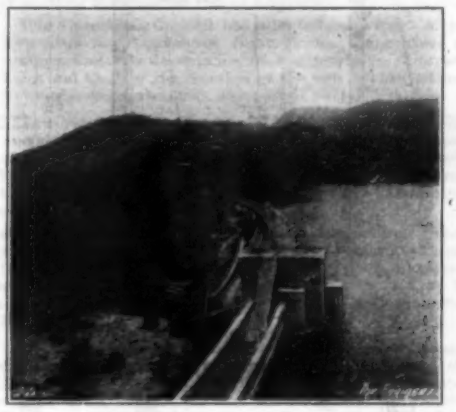


FIG. 3—VIEW ALONG DAM FROM THE EAST

as close together as possible without actually touching each other into the spaces between the plums, after they had been filled in with mortar.

A feature of the design is the curtain wall in front of the inner toe of the dam, which consists of a continuous layer of bituminous sheeting surrounded by lime concrete. This has been carried down into the rock to a point below any joints or fissures, and is tied into the face stone of the dam just below ground level. The culvert, which took the discharge of the Rajdaha stream during the period of construction, is 12ft. diameter, and was made of six rings of Raneegunge pressed bricks. When the dam was sufficiently complete for the water in the reservoir to be allowed to rise, the culvert was closed by a bulkhead consisting of two walls of cement brick-

FIG. 4—DOWNSTREAM FACE SHOWING DISCHARGE CULVERT

work with cement concrete between. An 18in. cast iron washout pipe was built through the bulkhead and closed by a sluice valve fixed in the discharge culvert.

In order to prevent any uplift, stoneware pipes, 3in. diameter, were built into any place where there was any possiblity of there being a sealed spring. They were carried up to above the original ground level and made to discharge into a longitudinal drainage tunnel constructed in the centre of the dam. The form of construction adopted has proved very successful. The discharge into the drainage tunnel when the reservoir is full is about 17,000 gallons per day. The lake was filled to within 3ft. of top water level in the rains of 1923 and afterwards left until the rains of 1924. The amount of loss during that period was no more than that accounted for by evaporation alone. For all practical purposes

the dam may be said to be absolutely water-tight.

The details of the valve tower will be seen in the lower drawing on page 722. The outlet is through a vertical stand-pipe in a central well, with branches at three different levels, 15ft. apart vertically. These branches terminate in three separate chambers, communicating with the reservoir through openings covered with fish screens.

The overflow weir consists of fifteen openings, each 25ft. wide between the piers of the road bridge over the dam. The discharge is over the downstream face of the dam into a tail-race, constructed of stones

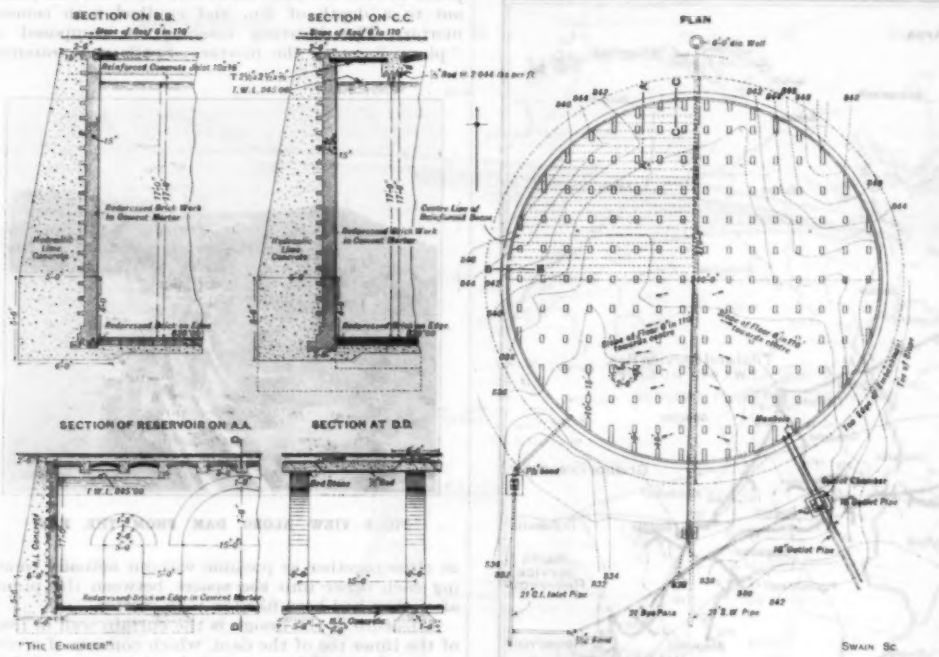


FIG. 5—THE TILATARD SERVICE RESERVOIR.

similar to those used for the facing of the dam. A battery of filters has been built, about 300ft. below the dam. There are at present six filters, each 130ft. by 50ft., space being left for extension if required. The filtered water passes through a recording chamber directly into the head of the conduit.

Cross sections of the conduit are shown in the right-hand bottom corner of the upper drawing on page 722. It is built of brickwork in lime mortar, backed with concrete, the inner face being rendered with cement plaster. The original design is that shown in the upper view. It was proposed to cover the conduit with stone slabs, but owing to the supply of these running short, part of the work was constructed with a flat brick arch, as shown in the lower view. The area of the cross section varies with the hydraulic gradient. The last 8 miles of the aqueduct to the service reservoir is in syphon, consisting of a line of 21in. cast iron pipes. There is a length of tunnel about half-mile long near Topchanchi village.

The Tilatand service reservoir has a capacity of 4,000,000 gallons. It is circular, with an inside diameter of 240ft., and a depth of water from top water level of 17ft. The walls are made of red pressed Raneegunge bricks in cement mortar, backed by hydraulic lime concrete. The roof consists of flat jack arches carried on reinforced concrete beams which rest on rows of brick arches spaced 15ft. apart. Details of the reservoir are shown in Fig. 5. In addition to the main service reservoir, there are some subsidiary service reservoirs. Details of the Godhor reservoir are shown in Fig. 6. This is circular, built of reinforced brickwork, with a reinforced brick roof. Its capacity is 150,000 gallons.

The construction of the main dam commenced in 1915. It had been intended by Mr. Williams that all the work at the reservoir should be carried on under the direct control of the Board's Engineer, but the Board came to the conclusion that it would be better that it should be constructed by a contractor, and after a period of delay—against the advice of its engineers—eventually let the contract to a Bengali contractor, who had had no previous experience of masonry on a large scale. The result was disastrous, and, although the contractor did his best under very difficult circumstances, it became more and more obvious that he would never be able to complete the works. His contract was finally terminated early in 1919. The method of direct administration was then reverted to, but in the meantime several years had been lost, and only a small fraction of the work of the dam had been completed in April, 1919, when the contractor handed over the works. Thereafter, progress was steady, although continually hampered by shortage of labour, and also by difficulties in obtaining materials, in the period following the war. The unskilled labour had to be all obtained locally. The supply of it was a very variable quantity, depending on the season of the year, but never sufficient for really rapid progress.

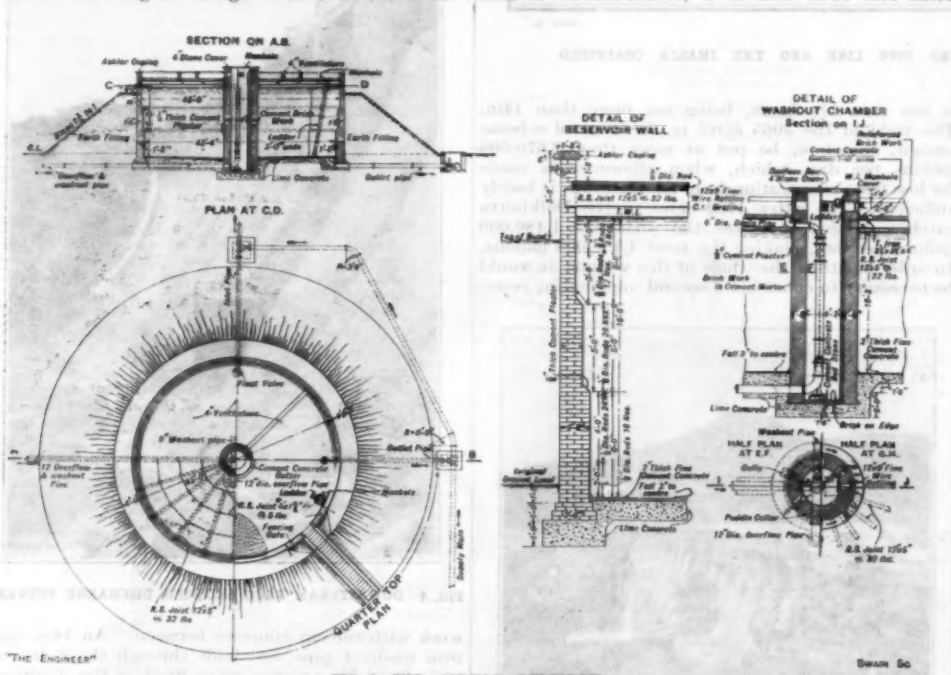


FIG. 6—THE GODHOR RESERVOIR.

The reservoir was finally filled on July 24th, 1924, by a heavy rainstorm, during which 3.75in. fell most of it in about four hours. This precipitation not only filled the reservoir from 9in. below top water level, but caused a discharge which reached a maximum of 50,000 cubic feet per minute to pass over the escape weir. A supply of water has been given in part of the coalfields since June 17th last, but up to the present only a portion of the distribution system has been laid. The remainder is being pushed on with, and water will be available in the whole of the area of supply at the end of another twelve or fifteen months.

The cost of the whole of the works will be about Rs. 7,000,000, which is more than double the amount of the original estimate. The chief reason for the excess is that common to all schemes prepared before the war—the great rise in the cost of labour and materials since the estimate was prepared. Mr. J. R. Taylor, M. Inst. C.E., was engineer in charge of the construction until 1921, when he was appointed Sanitary Engineer to the Government of Behar and Orissa, and Mr. J. S. Jackson, Assoc. M. Inst. C.E., succeeded him. Mr. G. Bransby Williams has been Consulting Engineer to the Board during the whole period of construction. Mr. E. S. Hoernle, I.C.S., is the chairman of the Board, a post he has held for the past five years.

SIXTY YEARS AGO.

OUR issue of December 23rd, 1864, recalls a lamentable accident which occurred on the South-Eastern Railway in the tunnel between Charlton and Blackheath. In 1857, it may be mentioned, a bad disaster had occurred on the same company's system a mile or so distant, namely, at Lewisham, the effect of which was to involve the company in an expenditure of £27,067 to meet claims for compensation. The Blackheath accident occurred on December 16th, 1864. A ballast train, weighing 120 tons, left Charlton in the afternoon on the up line and struggled through two-thirds of the tunnel between Charlton and Blackheath, when it came to a standstill from lack of adhesion. Ten minutes or so afterwards an express passenger up train also entered the tunnel, and crashed into the rear of the ballast train. The casualties were not recorded in our issue, but they were apparently severe. The tunnel has a length of 1688 yards, and has a maximum rising gradient of about 1 in 150 against up trains. Even at that date it was notorious for its dampness, and the poor foothold which its greasy rails afforded locomotives passing through it. From the evidence at the inquest, it would appear that the ballast train had been held up at Charlton for about a quarter of an hour. Had it not been delayed, it would probably, it was said, have possessed sufficient impetus to carry it through the tunnel. This delay was therefore regarded as a remote cause of the accident. As the tunnel formed a section of the signalling system, and as the rules prohibited two trains being on the same section at the same time, some failure on the part of the signals or of the signalman was indicated as a more direct cause. But the chief circumstance leading to the disaster was, in our eyes, the failure of the engine to secure sufficient adhesion on the rails. This subject had been dealt with fully in immediately preceding issues of this journal, and the disaster was regarded by us as a lamentable comment on our articles. We called attention to the fact that, according to the fireman's evidence, he had to descend from the footplate when the engine was crawling through the tunnel and kick ballast along the rails in order to make the wheels bite. We held up to scorn the "miserable little boxes" then commonly employed for holding sand on locomotives, and strongly urged the adoption of an efficient system of sanding. By the proper and legitimate use of sand any amount of adhesion which an ordinary engine could utilise could, we stated, be secured, no matter in what state the rails might be. The Blackheath Tunnel is to-day as gloomy as, and scarcely drier than, it was sixty years ago. Fortunately, our sanding and signalling arrangements have been so improved as to prevent any great likelihood of a similar mishap occurring.

A COMMITTEE, presided over by Mr. A. F. Round, signal engineer to the Southern area, London and North-Eastern Railway, recently reported to the Institution of Railway Signal Engineers on the question of three-position signalling. For those of our readers to whom this method is novel, we would say that the idea is of American origin, having been introduced there about 1906. It is now employed in this country on the Keadby deviation, Ealing and Shepherd's Bush, Marylebone–Wembley, and on the Metropolitan, together with to quite an extent in Victoria, New South Wales, and New Zealand. Both semaphores and light signals are used, and the first recommendation of the committee is that the scheme should be spoken of as three-aspect, and not three-position. The basic principle is that the normal aspect, with a red light, indicates stop; that the second aspect, with a yellow light, means "caution"; and that the third aspect, with a green light, intimates "clear." Thus, the indication given by an upper stop arm at "clear" and a lower distant arm in the "on" position, would be served by one arm or one light in the second aspect, or were the distant "off" by the third aspect, "clear." Distant signals on posts by themselves and not under stop arms would normally be in the second aspect. The main trouble with three-aspect signalling has been that a driver seeing a "caution" aspect, might not have sufficient braking distance in which to pull up before reaching the next signal. The committee recommends therefore a fourth aspect, "attention: run at medium speed," to be served by two yellow lights. One yellow light would be placed where there was the full braking distance. The report suggests that day colour light signals are satisfactory, and recommends that all three-aspect signals be of that type.

Railway Matters.

THE recent death of Mr. August Belmont, who financed the Interborough Rapid Transit Company, which works the New York Subway, reminds us that that railway was opened just twenty years ago. It was put into public service on October 27th, 1904, and some figures recently published show that in the first year the number of passengers carried was 116,000,000, and the car mileage 29,471,154; last year these two figures were 715,000,000 and 124,025,653 respectively.

SINCE the Cunard steamers, on their eastwards voyage began, on September 15th, to call at Plymouth before proceeding to Cherbourg and thence to Southampton, some remarkable runs have been made by the Great Western from Plymouth. On the evening of the 8th a new record was achieved by the special conveying passengers from the Mauretania, the train arriving at Paddington 17 min. under schedule time. The 227 miles were covered in 233 min. with a train weighing 350 tons.

THAT locomotives formerly belonging to the Great Northern and Great Central Railways now have the shortened funnels that characterised the North British engines may, perhaps, call for an explanation. The change has been made in order that the engines may run almost anywhere on the London and North-Eastern Railway, and they must conform to the limited structure gauge of the North British system. This limits the height in the centre to 12ft. 11in., as compared with 13ft. 9in. on the Great Northern and North-Eastern, and 13ft. 5in. on the Great Central.

SINCE Sir William Joynson-Hicks' speech at the opening of the City Railway there have been several suggestions from correspondents in *The Times* as to where new tubes would be serviceable. Among them is a proposed line from Hyde Park Corner to Victoria. Whilst it may be true that many need to make this journey, it has to be remembered that it is the long distance fares that pay, and that little profit would come to a tube where the corresponding omnibus fare is one penny. A tube to connect the northern termini with Victoria is a second suggestion but this is another unprofitable scheme seeing that all the stations served by the northern lines are connected by tube to Charing Cross, whence there is ready communication with Victoria.

THE accident returns for the year 1923 for the railways of the United States are the best yet recorded. Fifty-four passengers were killed in train accidents as compared with 106 in 1922, and 181 in 1913, and 275 servants as against 253 in 1922 and 569 in 1913. The servants killed in "movement" accidents numbered 1288 in 1923, as compared with 988 in 1922, 901 in 1921, and 1685 in 1920. These figures correspond, we believe, with the volume of traffic, *i.e.*, the greater the traffic the greater the number of accidents. There yet remains one scandal connected with American railway accidents, and that is the number of trespassers who are killed or hurt. Those killed in 1923, 1922, 1921 and 1920 numbered 2727, 2383, 2432 and 2118, and those injured 2962, 2786, 2930 and 2291 respectively. The blame for this lies less with the railway companies than with the police. The latter are either powerless or indifferent.

THE railway statistics for the month of September, prepared by the Ministry of Transport, have just been issued as a Stationery Office publication. They show that 6,014,079 more passengers were carried at reduced fares than in September, 1923, but 1,358,887 fewer at full fares. The result was an increase of 4.4 per cent. in the number of passenger journeys, and, what is more gratifying, an advance of 8.1 per cent. in the receipts. Moreover, these were carried and earned with an increase of 7.4 per cent. in the passenger train mileage. The freight traffic figures also are satisfactory. Despite a decrease in coal, coke and patent fuel of 804,857 tons, there was an increase of 237,520 tons, or 0.8 per cent. in freight traffic generally, and receipts were up by 7.5 per cent., with an increase of 5.2 per cent. in freight train mileage. Ton-mileage was 4.3 per cent. higher, but the average train load decreased from 133¼ tons to 123¾ tons and the net ton miles per engine hour from 460⅞ to 451.

THE demands for higher wages and better conditions for men in all grades submitted by the National Union of Railwaymen have now been placed in the hands of the railway companies, and presumably will be the subject of many discussions in the New Year. A railway authority has estimated the increased cost at 30 million pounds a year, but a trade union official says that this is much too high a figure. The Labour Correspondent of the *Manchester Guardian*, in a recent issue, reproduced some very useful figures which were got out in May last in order to help the Miners' Federation to show that miners were worse off than other grades. These figures indicated that most railwaymen were from about 100 to about 200 per cent. better off in 1924 than in 1914. It must not be forgotten that under the Railways Act, 1921, the companies are entitled to a guaranteed return, and that rates and fares have, as a general principle, to be fixed to ensure it.

THE formation of the Great Southern (Ireland) Railway Company as an amalgamation of all the railways, except the Dublin and South-Eastern, wholly in the Irish Free State, was mentioned in this column on November 28th, and on September 5th and October 10th we explained why the Dublin and South-Eastern was excluded. When the Railway Tribunal met on the 8th inst. to confirm the first-named amalgamation, it was announced that terms had been agreed with the Dublin and South-Eastern, whereby the subsidy of £20,000 a year hitherto paid by the London, Midland and Scottish would be continued to the new larger company, conditionally on Mr. H. G. Burgess being made a director. Mr. Brown, K.C., for the Great Southern Company, said the agreement with the London, Midland and Scottish was one which gave immense benefits to the amalgamated company, which were not to be measured by £15,000 or £20,000 a year, which was the money value of the division of rates. The agreement was not to be measured by what they got out of it in money, but by the cordial co-operation between the amalgamated company and the great company on the other side which controlled the traffic of every port but one on the west coast of England. The amalgamation was agreed to.

Notes and Memoranda.

THE High Commissioner in London for the Commonwealth of Australia reports that the Sea Carriage of Goods Act recently passed by the Australian Federal Parliament, embodying the Hague Rules relating to Bills of Lading, will come into operation on January 1st, 1925.

THE Postmaster-General has given authority to the Mersey Docks and Harbour Board for radio-telephonic communication to be used between the Crosby lightship and the Liverpool dock offices on the general conditions applicable to the Bar and Formby lightships for commercial and life-saving purposes, pending the granting of the necessary licence. All three Mersey lightships—the Bar, Formby and Crosby—are now in radio-telephonic communication with the Dock Board offices.

IT was stated in evidence before the Royal Commission on Mining Subsidence that the damage done in North Staffordshire in the last thirty years was £135,000, representing about one-sixth of a penny a ton of output. Mr. F. A. Cowley, clerk of Northwich Salt Compensation Board, stated that in the past twenty-seven years the number of claims for compensation by property owners in that area was 3305. The total sums claimed were £198,688, the amount allowed by the board being £82,754.

AN interesting experiment is at present being carried out at the Christchurch (N.Z.) Botanic Gardens by Mr. James Young, with a set of electric lamps in one of the propagating houses, with a view to forcing the growth of a number of annuals. The plants are given five hours' additional light daily, and by way of comparison, similar plants are being grown under normal conditions. According to the *Industrial Australian and Mining Standard*, those grown beneath the electric light made, on an average, a 25 per cent. greater growth than the others.

AT a recent meeting of the Institution of Mining Engineers Dr. J. S. Haldane advocated the use of carbon dioxide in combating the effects of carbon monoxide gas poisoning. As soon as the acute want of oxygen is relieved by inhaling pure oxygen, the breathing at once diminishes greatly, and, as a consequence, the carbon monoxide is not got rid of much faster than if air were breathed. In order to remedy this defect, and expedite to the maximum extent the expulsion of carbon monoxide, about 5 per cent. of carbon dioxide is added to the oxygen used for treatment. With this addition the oxygen is far more effective. Very large quantities of it are breathed, since the breathing is greatly stimulated; and the carbon monoxide is consequently expelled far more rapidly than when either pure oxygen or air is used.

SEVERAL examples may be cited, states the *Electrical World*, where the victim of electric shock has been resuscitated immediately after the shock and yet has died later because ordinary precautions were not observed. For example, the placing of the victim on his back in an ambulance sometimes leads to death, even after the prone-pressure method has succeeded in reviving him. The jar of the ambulance and the position of the patient may cause the tongue to fall back and prevent breathing, or the cessation of the resuscitation process may permit a relapse into coma. Every precaution should be used to continue the mechanical process of resuscitation to its final stages, for, like cranking an automobile, it frequently requires several starts to ensure the smooth and continued operations of the human engine. In safety work of this character there must be no lapse of attention until the patient has fully recovered, and the good work done immediately after an accident should be continued until there is no possible chance of a relapse.

ACCORDING to the *Electrical Review*, the question of using electric omnibuses in Sweden was raised by Mr. Wendt at the annual conference of the Swedish Tramway Association. It was pointed out that proposals had been brought forward on many occasions with regard to the employment of electric omnibuses equipped with secondary batteries, but they had not led—at least in Sweden—to any positive results on account of the great weight of the cells and their relatively low capacity. The question would therefore have to remain in abeyance until the problem of producing light accumulators had been solved. On the other hand, the introduction of trolley omnibuses, he said, had, or would, come. According to a graphic table, presented by the author, which compares petrol or oil-driven omnibuses and electric trolley omnibuses, if the price of petrol as motive fuel was taken at 20 ore per litre and that of electrical energy at 8 ore per kilowatt-hour, it would be more economical to use petrol motor vehicles than electric trolley omnibuses for a twenty minutes' service. If the service were increased to one of fifteen minutes, the question of economy of the two systems was doubtful, but in the case of a more frequent service of, say, five or ten minutes, it was decidedly more advantageous to employ electric trolley omnibuses.

AT the informal meeting of the Institution of Electrical Engineers, held on Monday, December 15th, Mr. F. Pooley was in the chair, and Mr. F. C. Raphael opened a discussion on "The New Wiring Regulations." A discussion of considerable importance was maintained until a late hour, and the chairman expressed the possibility that another evening might be allocated to the subject later in the session. The objections in the main boiled down to very little indeed, and chiefly arose from a desire not to increase further the cost of installation. It was shown, however, that expert estimators calculated the increased costs of installations at very small percentages. After reviewing the origin and intention of the wiring regulations, Mr. Raphael criticised many of their stipulations, but his chief concern seemed to be for the status of existing installations now in service, which did not conform to the new regulations and which obviously cou'd not be condemned. The discussion made it clear that the regulations do not proscribe existing work, nor can they be enforced for future installations, but must be regarded as a standard specification for a first-class job according to the lights of 1924. Mr. Ll. B. Atkinson said all rules must contain a large element of compromise, and no member of the Committee would dispute that some of the rules could be amended, but he had no use for the school of thought which wished to be without rules and felt any installation should pass if it did its job.

Miscellanea.

THE River Wear Commissioners have decided to construct railway sidings on the new Barracks site, adjoining the Sunderland docks.

A START has been made on the alterations to the Birmingham Post Office, necessary for the accommodation of the automatic telephone system.

TEES shipbuilders record the biggest output of new tonnage since 1919. Compared with thirty new ships and a tonnage of 75,570 last year, they have this year built seventy-two new ships, of 185,182 tons gross.

A NOTE in the *Birmingham Post* states that a new apparatus for catching the grit discharged from the chimneys of the Nechells power-house is being installed. No particulars of its construction are given, but it is hoped to have it working towards the end of January.

THE Gateshead Council has adopted the report of the Newcastle and Gateshead Joint Bridge Committee, recommending the acceptance of the tender of Dorman, Long and Co., for the erection of the new bridge between Newcastle and Gateshead, at a cost of £571,225 1s. 8d.

THE Victoria Railways Standing Committee has under consideration the proposal of the Railways Department to remove from their present sites the way and works branch, ironworks, wood-working shop, and girder reclamation depôt, to a new site at Spotswood. The expenditure entailed is estimated at £200,000.

ACCORDING to the *Ironmonger*, the biggest iron water-wheel in the United Kingdom, which has been used since 1847 to drive the woollen mills of G. Lawton and Sons, at Diggle, near Oldham, is now being dismantled, to be replaced by a turbine. The wheel is 64ft. 8in. in diameter, 7ft. wide, and yields 140 horse-power.

ANOTHER extensive programme of new works and various waterfront improvements has been planned by the Auckland (New Zealand) Harbour Board. The estimated cost of these, distributed over several years, is £750,000. The main purpose of the necessary Empowering Bill, which has been passed by Parliament, is to authorise the Board to raise a loan of £1,000,000.

THE contract for the supply of power-signalling apparatus required in connection with the enlargement of the Central Argentine Railway Company's terminal station and yard at Retiro, Buenos Aires, and the rearrangement of the tracks up to and including Maldonado Junction, has been awarded to the British Power Railway Signalling Company, Limited, of Slough and Westminster.

THE Special Commission appointed some time ago to consider the question of the electrification of the railways in the Belgian Congo has now presented a report, in which it is recommended that, having regard to the fact that the work of surveying the water power resources of the Lower Congo, which has been in hand since 1910, is now completed, the first 56 miles of the Congo Railway should be immediately electrified. It is also suggested that a company be formed to establish hydro-electric plant to utilise the water power of the Lower Congo.

THE Ontario Municipal Electric Association has condemned the delay of the Dominion Government in approving the plans of the Ontario Hydro-Electric Commission for power development at Morrisburg, on the St. Lawrence River. It also condemns the proposal of the Canadian Deep Waterways Association that St. Lawrence power should be developed by the Federal Government. The Hydro-Electric Commission offers to spend 40 million dollars (£8,000,000), half the amount required for building the dam at Morrisburg, on condition that the other half shall be furnished by the State of New York or private power companies.

THE coal output for the week ending December 6th was, according to the Board of Trade *Journal*, 5,336,300 tons, against 5,303,400 tons in the previous week and 5,728,800 tons the corresponding week last year, while the wage earners employed numbered 1,136,500, compared with 1,137,200 the week previous. The principal increase (42,000 tons) was in Scotland, but there was a decrease of 12,000 in Northumberland, the output in other districts varying comparatively slightly. The Yorkshire figures rose from 972,800 to 981,900, while those for Derby, Nottingham and Leicester fell from 671,900 to 668,300 tons.

IT was reported at a recent meeting of the Torquay Corporation that the output of the electrical generating station at Newton Abbot continues to increase rapidly, and that application is to be made to the Electricity Commissioners for consent to extend the station. Mr. Woods, the electrical engineer, has been asked to act as consulting engineer in connection with the extension and installation of additional plant. The Stoneycombe Lime and Stone Company has signified its willingness to take a supply of electricity, and it was recommended that the necessary arrangements be made, subject to an agreement being entered into. It was mentioned that the company would take a day load, and would consume 250,000 kilowatts a year, to supply which it would be necessary to lay an extra-high-pressure main from Kingskerswell.

IMPORTATIONS of coal into Argentina in 1923 were 2,220,109 metric tons, compared with 4,046,278 tons in 1913. During the first eight months of 1924 imports of British coal at Buenos Aires and La Plata amounted to 1,211,473 tons and at other ports to 760,869 tons, or a total of 1,972,342 tons, showing an increase of 388,619 tons over the corresponding period of 1923. American coals imported totalled 102,388 tons during the 1924 and 107,358 tons during the 1923 period. Increased imports during the current year are due to lower ruling prices, which have influenced consumers of fuel oil to use coal. During 1924 a cargo of 4085 tons of South African coal was delivered, but it does not appear to have been favourably received. A cargo of German coal has also arrived, and it is thought that in the near future German coal may compete with British in the River Plate. The principal receivers of American coal are meat-freezing works at La Plata.

SEWAGE DISPOSAL PLANT AT HANLEY

HARTLEY, SONS AND CO., STOKE-ON-TRENT, ENGINEERS

(*For description see page* 731)

FIG. 1—1924. BALANCED-ARM WATER-WHEEL-DRIVEN CIRCULAR SEWAGE DISTRIBUTOR

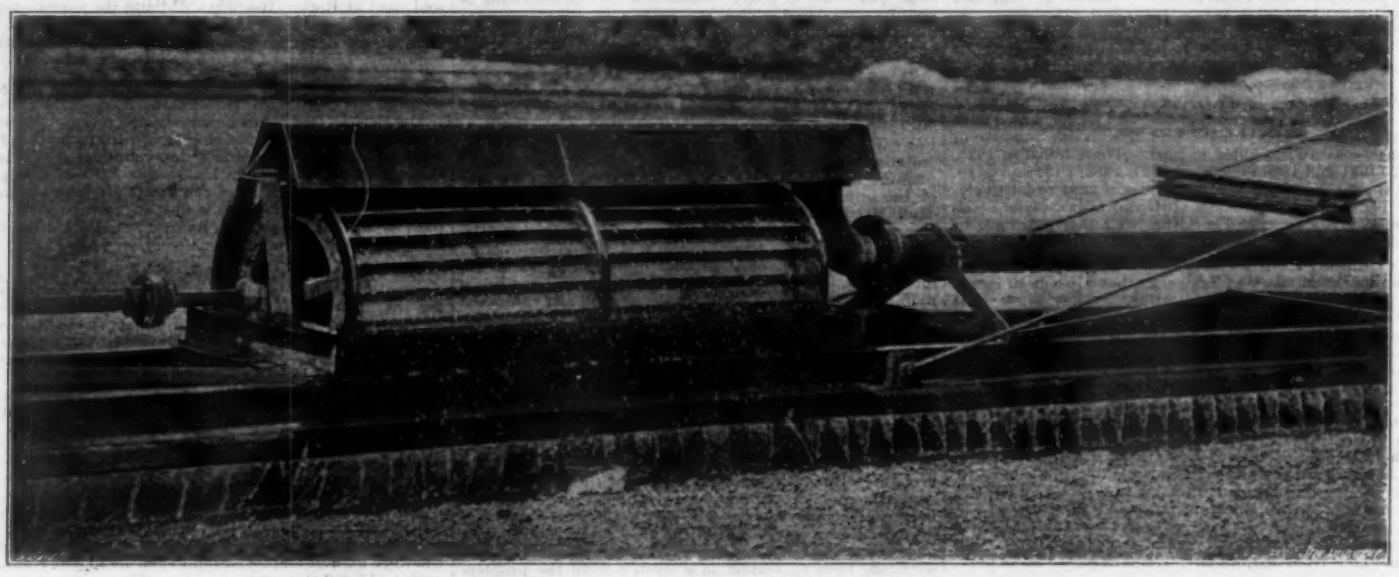


FIG. 2—WATER-WHEEL FOR DRIVING SEWAGE DISTRIBUTOR

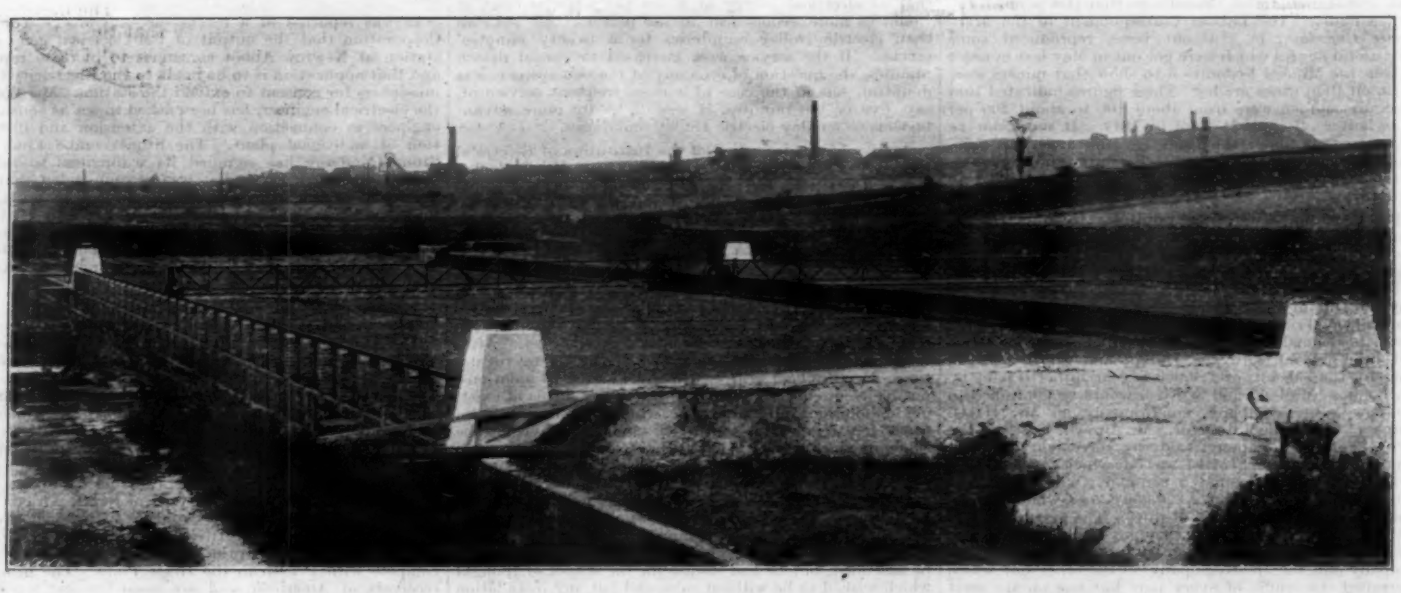


FIG. 3—BALANCED RECTANGULAR SEWAGE DISTRIBUTORS DRIVEN BY FIXED WATER-WHEEL

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Editorial Announcement.

THE RAILWAY CENTENARY, 1825–1925.

In preparation for the Railway Centenary, which will be celebrated in the coming year, a new history of the steam locomotive in Great Britain will appear in serial form in the pages of THE ENGINEER, *beginning on January 2nd, 1925. It has been written by Mr. E. L. Ahrons, and as all recent researches have been carefully scrutinised, it may be safely described as the most accurate history of locomotives which has ever been compiled. It will, of course, be fully illustrated, and it is unnecessary to say to readers of* THE ENGINEER *who are well acquainted with Mr. Ahrons' work, that it will be as interesting as accurate.*

THE ENGINEER.

DECEMBER 26, 1924.

Fibre in Metals.

IN a paper recently read to the Royal Aeronautical Society, Colonel Belaiew puts forward the view that in order to improve our metals, whether steels or light alloys, we should endeavour to produce in them a fibrous structure more or less resembling that of wood, and he cites in support of his view the results attained by ancient oriental smiths in the production of "damascened" steel swords and armour. He tells us how it was customary to judge of the value of a piece of steel for such purposes by the character of the "watering" or damascening developed upon its surface by the attack of vegetable acids—a kind of macro-etching. He speaks of the original dendrites which are formed when steel first solidifies, and how, by skilful forging, they are "woven into an inextricable maze of fibres." Put forward by a metallurgist worthy of serious attention, this theory deserves to be carefully considered and analysed; if it is based upon a true appreciation of the meaning and value of "fibre" in metals, it should shape our efforts in a very definite direction; if, on the other hand, it is based on a misconception it should be cleared away before time and money is wasted upon attempts to produce the fibrous condition.

The conception of a fibrous structure as one having particular strength is clearly based upon an analogy with such materials as wood and textiles. In them, strength is almost entirely concentrated in the longitudinal cohesion of the fibres themselves, the transverse attachment of one fibre to another being extremely weak, except where, as in a fabric, interlacing fibres are provided to afford strength "across the grain." Now there can be no doubt that the fibres of wood are, for their weight, very strong, and it is for some purposes eminently desirable that this strength should be fully available—if possible—in all directions. But it must be pointed out at once that there is no sort of mysterious strength or virtue about a "fibre" as such; it is merely an elongated structure in which the full cohesive strength of the material is developed, and it appears as a fibre mainly because its longitudinal strength is so much greater than the adhesion between adjacent fibres. If it were possible to obtain a material like wood in which the full cohesive strength of the fibre were also developed transversely, the material would undeniably be enormously stronger, but—and this is the main point—it would no longer be a fibrous substance, but a completely homogenous one. Actually, in using timber, we have to reckon upon the lateral weakness and for some purposes have learnt to overcome it by supplying layers of transverse fibres—as in the well-known plywood. If the fibres could be intimately interlaced, a still better result would be obtained, but even then would fall far short of the homogeneous non-fibrous material of uniform strength and texture in all directions. In wood, we are not able to produce such a structure, since the fibres are the inherent result of natural growth. Wood with twisted or irregular grain is not a desirable thing, since the inter-fibre weakness is apt to make itself felt in undesired places. With this view—and we believe it is the rational one—of the nature and function of natural fibre, we may consider the nature of fibre in metals. The most familiar example is the "fibre" of wrought iron, which is so clearly developed by macro-etching, micro-structure or fracture. It is clearly due to the fact that we have here a material which contains a relatively large amount of foreign matter—cinder or slag—which is drawn out into threads and sheets, and serves to separate the iron into longitudinal bars or rods, giving the fibrous texture. Within the "fibres" themselves we have a structure of crystals of iron or "ferrite," which is often very pure, ductile and tough, but within this fibre there is no special longitudinal strength. Between the fibres, on the other hand, there is great lateral weakness and even from the point of view of direct longitudinal tensile strength the cinder enclosures are a definite though not very great disadvantage—if they were replaced by iron, the bar would be stronger both longitudinally and still more so transversely. The only remaining question, then, is whether the separation of the iron into bands by intervening layers of weak and brittle material can in any circumstances be an advantage. One claim sometimes made is that the cinder bands serve to stop the propagation of a crack, whether due to shock or fatigue, but we believe that this claim has never been established. Their unyielding nature may at times afford some little support to the soft adjacent ferrite, but they are too weak and brittle to be really effective. Only when the material is stressed in such a way as to shear the "fibres" past each other do these cinder bands play an important part; they are so weak that they allow of shearing movement between the fibres, and the bar acts more like a bundle of plates or rods than as single pieces of metal. This structure gives, for example, remarkably high values under a notched-bar impact test, but the same effect could be obtained with much greater certainty and regularity by deliberately using a bundle of plates or laminæ, as we do in our laminated springs. The inevitable inference, in fact, seems to be that the "fibrous" structure carries with it no increased longitudinal strength, but a greatly decreased transverse strength. There is a similar kind of fibre which is frequently met in steel in which non-metallic enclosures are abundant, and the deleterious effects of this kind of "fibre" are well known. In justice to Colonel Belaiew, however, it must be said that this is not, perhaps, the kind of fibre he has in mind, although much of the macro-etching effect he describes must be due to the distribution of non-metallic impurities, particularly in ancient steel, which is often full of such bodies. It is suggested in the paper to which we have referred that the "fibre" is in reality caused by the elongation and bending into threads and bands of the original dendrites formed when the steel solidifies. To a large extent, this is true in steels containing considerable amounts of phosphorus or even of manganese, but the non-metallic enclosures always follow the same distribution, and it is difficult to disentangle the two effects. The dendrites themselves, however, cannot be regarded as structures having any special strength or toughness. They are, when first formed, simply the cores of the original crystals, themselves consisting of the purest steel, their peripheral regions containing material

richer in impurities or alloying elements. But they do not persist as crystals since at the transformation points the iron entirely re-arranges its structure; all that persists is the distribution of some of the impurities, such as phosphorus, which cannot readily distribute themselves by diffusion. Apart from enclosures, therefore, the "fibre" merely represents the distribution of impurities derived from micro-segregation in the ingot. It is difficult to conceive that such fibres have any special longitudinal strength higher than that of homogeneous metal while they certainly entail transverse weakness.

If this view be correct and existing metallurgical knowledge seems to us to establish it quite definitely, then Colonel Belaiew's contention is misleading. It is true that if we cannot avoid the formation of a fibrous structure—*i.e.*, if planes or surfaces of relative weakness unavoidably exist in our metals—it is highly important to secure that they shall be distributed so as to be least injurious, and this, we take it, is what the ancient smiths brought about in the damascened blade. It is quite another matter, however, to suggest that "fibre" in itself is in any way desirable, or, indeed, anything but a detriment to the metal. The problem for our metallurgists, indeed, should be that of eliminating all sources of weakness, whether in dendrites or fibres, as completely as possible. The elimination of non-metallic enclosures is already a well-understood aim, and the elimination of dendritic micro-segregation, either by the removal of the impurities that give rise to it or by subsequent thermal and mechanical treatment which shall facilitate diffusion and render the metal as homogeneous as possible, is a much more difficult task. It is one, however, which we hope our metallurgists will attack in the future, rather than that of the production of fibres, not stronger in themselves, but weaker in the mutual cohesion, however well distributed.

The Railways of New South Wales.

On the whole, State-owned railways are a mistake. The lack of competition leads to inefficiency; the deeper pocket of the State causes extravagance; a want of funds for development is always a sequel to the necessity of keeping taxes low; the desirability of getting a profit from the railways causes high rates and fares; the wish to secure or to retain the labour vote results in unjustified concessions to railway servants; and, whilst with company administration, the man with a big traffic may get concessions, it is, with a State railway, often the man with the political pull—with no traffic to give as compensation—who gets preferential treatment. It is true that not all these conditions are to be found on every State-owned railway; in fact, many such are well administered concerns. We have, for instance, in the past more than once spoken with appreciation of the railways of South Africa, and, within the last ten days or so the receipt of the annual report for 1923–24 of the Victorian Government Railways has furnished us with another example. The ratio of working expenses to receipts in Victoria was only 72.87. That was not, moreover, achieved by starving the line, as the expenditure for 1923–24 was nearly one million pounds more than in 1920–21, whilst one and a half millions more were earned. In no respect can the standard of operating efficiency be better measured than in the punctuality of the trains. In Victoria, during the past year, 83.21 per cent. of the passenger trains and 81.49 per cent. of the mixed—passenger and goods combined—trains were punctual, and 87.59 per cent. of the suburban electric trains. The last figure was not as good as the excellent 93.08 per cent. of 1922–23, because, it is explained, engineering works in Melbourne yard necessitated speed restrictions for the greater part of the past year. The number of passengers carried by electric trains was 158½ millions—to appreciate the value of this record we would say that our Metropolitan District Railway carried 127 millions—which was an increase of 63.4 per cent. above the total of the last steam-train year (1917–18.) The automatic signalling installation in the Melbourne area is one that is not excelled by any other in the world, and on many sections trains may follow at intervals of two minutes, and on all other parts the headway is three minutes. What has struck us also as commendable and an adjustment that has not been made on any English railway that has substituted electric traction for steam operation, is that capital was credited last year with £50,000 for locomotives displaced by electrification.

It is, however, with the railways of New South Wales that we are at the moment chiefly concerned. Because of discussions in the Legislative Assembly upon railway administration generally, including the re-appointment or otherwise of the present Railway Commissioners, Sir Sam Fay and Sir Vincent Raven were appointed as a Royal Commission to inquire fully into the finance, management, equipment and general working of those railways. The report of these engineers was dated October 3rd, and a copy of it, sent by the Chief Commissioner of Railways, recently reached us by the Australian mail. We would at once say that the document is an absolute and complete vindication of the administration. It is also very important to note that it is observed that there was "no evidence that public policy which decreed that railways in New South Wales should be State-owned and managed is likely to change." The ratio of working expenditure to receipts is only 69.87—better than the Victorian figure given above—and in 1922–23 the net earnings were equivalent to 5.22 per cent. profit on the capital, and last year they were 5.13 per cent. The New South Wales Railway Administration—like the Railway Board in India—has been crippled by the Railway Budget being part of that for the State, and consequently, to quote Mr. Fraser, the Chief Railway Commissioner, the estimates of the railway officers as to the amount of money required "have generally been greater than the amounts which the Government has been able to provide, and expenditure in both connections—capital and revenue—has therefore been restricted to the lowest possible minimum." From letters quoted in the report and from the general trend of the evidence, it is clear that considerable pressure is brought to bear upon the Chief Commissioner to reduce estimates year by year, in order to enable the Treasurer to produce a balanced State Budget—the inevitable result of State financial stringency. As an illustration we would say that business was 38½ per cent. greater in 1921 than in 1914, but there were only 22 per cent. more locomotives, 13 per cent. more carriages and 9 per cent. more wagons. In new works it was the same. One of the many grievances was the lateness in the year when the votes were available. As Mr. Fraser said, "You want to begin to spend on the first day of the twelve months, and to continue your expenditure fairly consistently throughout the whole period. That is a thing which the Railway Department has never been able to do, either from loan or on the working expenditure side." Sir Sam and Sir Vincent therefore recommended that the finance of the railways be taken out of Treasury hands, and that the Railway Commissioners be given control of their own funds. They say that the railways should "be so worked and managed that the gross receipts shall not be more than sufficient to cover working expenses, reserves and the interest on capital, including sinking funds; that in the event of a surplus, it be devoted to reduction of rates and fares. If, on the other hand, a loss appears, that rates and fares be increased to cover the deficit." The report also proposes that the standing salaries and responsibilities of the Railway Commissioners be improved. Their period of office should be indefinite—"a Chief Commissioner should have a vision and an aim beyond seven years." The Chief Commissioner should select his own assistants—"his is the responsibility and upon him would fall the result of failure. Moreover, his share of the work and his personal comfort are so involved in the choice of competent and tactful assistants that he is not likely to be influenced by any motive other than that of securing the very best man for each position." Whilst it might not be within their province, the Royal Commissioners which ventured to offer some remarks on the question of the remuneration of the Railway Commissioners. That is now on so low a scale as to be out of proportion to those paid in other countries, and has an effect upon the pay of the principal technical officers.

One of the recommendations of the Fay-Raven Commission has relation to the railway situation in this country. It is proposed that, in addition to a Chief Commissioner at £5000 and two Assistant Chief Commissioners at £4000 each, there should be three Area Assistant Commissioners at £2500 a year each. These latter officers would each be given an area with a view, partly, to decentralisation, thus relieving the headquarters at Sydney of a mass of detail and correspondence, and, partly, to the development of the areas. It is said that centralisation, with its attendant circumlocution, no longer enables the Commissioners to manage the various interests committed to their charge as effectively as would be the case under a system of decentralisation. If that be the case, are not we in Great Britain attempting too much in the way in which, under grouping, centralisation has been developed? We have more particularly in mind the case of the London, Midland and Scottish Railway. Prior to two years ago, the London and North-Western and the Midland were each, in all conscience, quite big concerns. Now they are not only amalgamated, but we have a couple of the principal minor companies, a dozen or so small lines, and the larger half of the Scottish railway system added to the two large concerns, which, in themselves, demanded the full attention of some of the ablest railway minds in this country. The centralisation that is so fatal to progress has, we are glad to say, not been put into force in the engineering branches of the London, Midland and Scottish, as the former chief constituents have been turned into divisions under divisional engineers responsible to an engineer-in-chief as regards civil engineering, a chief mechanical engineer as regards locomotives and power, and a chief carriage and wagon superintendent as regards rolling stock. It is on what are called the traffic and the operating sides that the weakness lies. There has been too much chopping and changing, and, as Sir Guy Granet, the chairman of the company, be it remembered, said at a dinner of the Weavers' Company a month ago, "some square pegs have gone into round holes." The trade and commerce of the country and its vast passenger traffic demands close, personal attention. Motor competition is becoming more severe, and rivalry between the companies themselves is more severe than it has been for thirty years. These are no new opinions of ours; we expressed them in a leader in The Engineer of June 18th, 1920, and again a fortnight later when Sir Eric Geddes had outlined his proposals; on more than one occasion when the Railways Bill of 1921 was under consideration; and particularly in relation to labour on November 3rd, 1922. The London and North-Eastern has done more wisely. It has a chief general manager for the whole of the system and divisional general managers for the Southern, North-Eastern and Scottish areas. The Great Western and the Southern can probably manage their lines from Paddington and Waterloo respectively. Centralisation not only brings to headquarters a mass of detail and correspondence, but it means delay in arriving at decisions. Furthermore, to quote the present report, it "leads distant officers to lean too much upon the central organisation, thus divorcing them from the responsibility which is theirs." If, then, decentralisation is necessary for the railways of New South Wales, it would seem that its adoption for the two larger groups of railways in this country is also advisable.

One Hundred Years of British Railways.

No. XXVI.*

THE SECOND HALF CENTURY.

AUGUST 4TH, 1914—DECEMBER, 1924.

CONCLUSION.

1914.—With the outbreak of war on August 4th came the testing time for British railways, but alone among the railway systems of the belligerent countries they not only stood the strain of the four years of war, but never once failed. It is a great temptation to refer to some of the magnificent feats they performed, but we must satisfy ourselves with saying that a record of them may be found in a series of articles on "British Railways under War Conditions," which opened in The Engineer of September 13th, 1918, and appeared at intervals until July 9th, 1920.

It is, however, necessary again to put on record that under the Regulation of the Forces Act, 1871, the Government took possession of the English and Scottish railways as soon as war was declared and arranged for their administration by the Board of Trade through a Railway Executive Committee. That control lasted until August 15th, 1921. Beyond those associated with the prosecution of the war there was no event of note during the last five months of 1914.

1915.—The Baker-street and Waterloo Railway was extended from Paddington to Kilburn on January 31st, to Queen's Park on the London and North-Western on February 14th, and to Willesden on May 10th. The doubling of the Metropolitan Railway from Finchley-road to Wembley Park was completed on May 31st; the Lothians Railways were brought into use on September 26th; and the first section—from Waterloo to East Putney—of the London and South-Western electrical services on October 25th.

* No. XXV. appeared December 19th.

During the year the reconstruction of Aberdeen Joint Station was finished.

The year 1915 was most remarkable for railway accidents. It was in that respect in direct contrast to the earlier months of war, and, strange to relate, the run of misfortune, experienced right through it, ended with it, and not until the beginning of 1921, with one exception, did another really serious accident occur. The year 1915 saw the worst accident ever known on British railways—Quintinshill, on May 22nd—and apart from that disaster there were four other bad cases.

A failure to obey an adverse distant signal at Ilford on the first day of the year led to a collision in which ten passengers were killed. Bad weather conditions—snow—caused a collision at Smithy Bridge on March 18th, in which three passengers lost their lives. In the Quintinshill accident 224 passengers and three servants were reported as killed. It arose through a passenger train that had been "shunted across" being forgotten, with the result that a special troop train ran into it. Into the obstruction thus created a down express ploughed its way. Fire subsequently broke out and added to the horrors of the terrible disaster that the second collision had brought about. A very unusual derailment happened at Weedon on August 14th. The right-hand coupling rod of an up train became detached and in its revolutions struck the down line and so damaged it that the down day Irish mail was derailed and ten passengers were killed. A collision, caused by a light engine being overlooked, at Jarrow on December 17th led to a fire in the coaches of the passenger train concerned. Eighteen passengers lost their lives in the collision or the subsequent fire.

1916.—The London and South-Western electrical service was extended on January 30th and again on June 18th; on November 20th the then programme was completed. The Manchester-Bury, *vid* Prestwich, electrification of the Lancashire and Yorkshire was completed on April 17th. The Gowdall-Braithwell Railway was opened on May 1st and the Keadby deviation—with the biggest bascule lift bridge outside the United States—on the 21st. The second section, from Broad-street to Richmond and Kew, of the London and North-Western electrification was brought into use on October 1st.

An arch in the Lancashire and Yorkshire Company's viaduct at Penistone collapsed on February 3rd and the line had to be closed until August 14th. On March 27th–28th widespread disorganisation of the railway system occurred as a result of a snowstorm.

Only three passengers lost their lives in accidents to trains, one passenger on each of three occasions. The closing days of the year, however, saw three serious accidents on the same date—December 19th—but in no case was a passenger killed. They were at Wigan, Kirkpatrick and Kiltemagh and all were primarily due to bad weather conditions—snow in the first two and fog in the last.

1917.—From the first day of the year the Irish railways were controlled by the Government, not directly a war measure, but because the British railwaymen, being paid by the State, received generous war bonuses which the Irish companies could not afford to pay their men.

On April 2nd the Mansfield Railway was opened for passenger traffic, and on the 16th of the same month electrical operation was put into force between Willesden and Watford. On August 6th it was announced that the management of the Taff Vale, Rhymney and Cardiff Railways was to be placed in the hands of one man, Mr. E. A. Prosser, then the general manager of the Rhymney. A threatened strike of enginemen in August was only averted on the 21st by the President of the Board of Trade promising to consider, when hostilities ceased, the men's demand for a shorter working day.

There was one fatal accident in 1917—at Ratho on January 3rd. The driver of a light engine assumed that because he had not been told to stand he might proceed, and the signalman assumed that because he had not told the driver to go ahead the engine would come to rest. The light engine fouled the path of an express and twelve passengers were killed.

1918.—With the prospect of a collapse of the enemy forces and a cessation of hostilities the future of the railways began to be a live question in the later months of 1918. On March 20th Mr. Lloyd George, the then Prime Minister, received a deputation from the Trades Union Congress to present arguments in favour of the nationalisation of railways, mines, &c., and it was understood that a sympathetic reply had been made. On September 7th Mr. G. N. Barnes, a member of the Cabinet, said that he could not agree to the railways returning to private management. In a speech on November 16th, in connection with the forthcoming General Election, Mr. Lloyd George advocated a policy of co-ordination of all forms of transport to be controlled by the State, and on December 4th Mr. Winston Churchill said that the Government had determined upon the nationalisation of railways.

In connection with the Ministry of Reconstruction an advisory council was called upon to report whether standardisation of railway equipment was advisable. The report, dated July 4th, 1918, was issued as Command Paper 9193. On July 28th there appeared the report—White Paper 417—of a Select Committee on Transport in the Metropolitan Area which dealt with overcrowding, alleged high fares, &c.

In August the Government executed a remarkable *volte face*. In reply to a question on the 5th as to the future administration of railways the President of the Board of Trade said it was not proposed to appoint a Committee to consider that question. On the following day, the 6th, the Chief Whip moved the appointment of a Select Committee on Transport, over which the late Mr. Wilson-Fox was to preside. Its report was issued on January 13th, 1919, as White Paper 136, and therein the view was unanimously expressed that railways could not revert to their pre-war position; that war control of railways would not be satisfactory as a permanent settlement; and that unification was desirable.

The Armistice was signed on November 11th and the President of the Board of Trade, on December 6th, redeemed his promise of August, 1917, as to considering shorter hours. Without any consultation with the railway companies the eight hours' day was given to all railwaymen, and an undertaking that a committee should be set up to consider conditions of service was entered into.

There were only two fatal accidents during 1918. A sudden landslide as an express was approaching caused it to be derailed near Lazonby on January 19th, and seven passengers were killed. The premature restoration of a signal at Aberdeen on June 15th led to a light engine colliding with a passenger train, whereby a youth was fatally injured.

1919.—The outstanding event of the year 1919 was the establishment of the Ministry of Transport with its creator, Sir Eric Geddes, as the first Minister. The Bill to give power for this action was introduced on February 26th, but before it was read a second time on March 17th, a section which gave the Minister power to purchase railways was withdrawn. In committee many other modifications in favour of the railways were made, and the Bill received the Royal Assent on August 15th, becoming 10 & 11 Geo. V., c. 50.

On February 2nd a strike took place on the tube railways and among the enginemen on the Great Western and the southern lines. The reason given for it was that nothing had been done towards setting up the committee to consider the conditions of service which had been promised by the President of the Board of Trade on the preceding December 6th. The companies pleaded that they had had no instructions, but meetings were arranged and a "national agreement" was signed on March 27th, which, besides dealing with all grades, stabilised the existing rates of wages, including the bonuses, until the end of the year. The agreement also contained the following important announcement:—"When the new Ministry of Ways and Communications"—the then proposed name of what became the Ministry of Transport—"is set up it is the intention of the Government to provide in the organisation for, and to avail itself fully of, the advantage of assistance, co-operation and advice from the workers in the transportation industry." In August the conditions of the enginemen were futher improved. On September 23rd the officers of the railway department of the Board of Trade were transferred to the Ministry of Transport, and on the same day Mr. J. H. Thomas issued a manifesto saying that the country was approaching a crisis in connection with the question of standardisation, which had been the subject of negotiation for six months. There was no threat of a strike, but by midnight on September 26th the whole of the railways came to a standstill. A meeting between Mr. Thomas and Mr. Lloyd George on the afternoon of Sunday, October 5th, brought the strike to an end, but what settled it and what really caused the strike are not known. It is fair to assume that the cause was the failure of the Government to "avail itself fully of the advantage of assistance, co-operation and advice from the workers in the transport industry." A possible sequel to this strike was the dismissal on December 8th of the Railway Executive Committee, which had so successfully managed the railways during the war, and its replacement by a railway advisory committee on which were four representatives of railway labour.

On May 14th there was published the celebrated Command Paper 147, "Railway Working During the War," which showed that during the period of control up to the end of 1918 the railways had rendered services to the Government to the value of nearly 130 million pounds, and that if this sum were added to the actual receipts there would have been a balance, after deducting the actual expenditure, of over 213 millions for the four years and nearly five months. It must be remembered, too, that despite the advanced cost of working, freight rates were at their 1913 level, and that they were not increased until January 15th, 1920. Passenger fares had been increased by 50 per cent. from January 1st, 1917, but in the hope of restraining traffic and not for revenue-earning purposes. Command Paper 402 brought these figures up to the end of June, 1918, and estimated that for the financial year ending March 31st, 1920, the deficit would be 45 millions.

The departmental committee to inquire into the methods for handling freight, proposed by Mr. A. W. Gattie, was appointed on July 23rd, 1919, and its report, Cmd. 492, was issued on December 22nd.

The Folkestone–Dover line, having been completely blocked by a landslide near The Warren on December 19th, 1915, was not reopened until August 11th, 1919. It November it was announced that the North-Eastern Railway intended to electrify the line between York and Newcastle. The railway conciliation scheme of 1911 having lapsed during the war a new scheme, with central and national wages boards, came into operation on December 8th. During the year only three passengers were killed in train accidents—one each in two derailments and one collision.

1920.—On January 4th, 1920, the new statistics as to mileage, tonnage, number of passengers, engine hours, loading of trains and wagons, coal and oil consumption, commodities carried, &c., came into operation. There were many complaints as to the cost the collection of these figures entailed, but the agitation has now long since died out. On and from January 15th large increases in freight rates were made in order to render the railways more self supporting. Later, the Rates Advisory Committee—a product of the Ministry of Transport Act—recommended further increases in fares and freight charges with a view to the deficit on the railways being wiped out before the control ceased in August, 1921—Command Papers 857 and 886. On December 30th the Tribunal's report, Cmd. 1098, on the general question of fares, rates, &c., was issued.

In March the Minister of Transport appointed an advisory committee, with Sir Alexander Kennedy as chairman, to report on certain phases in connection with railway electrification. The committee made an interim report in October.

In anticipation of the discussion on the vote for the Ministry of Transport, Command Paper 654, a "Statement as to Railways" was issued on April 12th. On June 20th Sir Eric Geddes, in Command Paper 787, outlined his proposals as to the future organisation of transport organisations. A statement as to the results of railway working for 1919–20, together with an estimate of the receipts and expenditure for 1920–21, appeared as Cmd. 815 on July 10th, and was followed by the above-mentioned recommendations of the Railway Rates Tribunal.

The agreements made from time to time by the Board of Trade with the railway companies necessarily left openings for disputed points. There was, for instance, the question of delayed upkeep and renewal, some portion of which it was not necessary to overtake, whilst some portion would have to be done at a higher cost than would have been the case had the work been carried out at the time. Another point was the alleged extra wear and tear of certain routes and rolling stock. To insure a correct interpretation of these agreements a departmental committee, with Lord Colwyn as chairman, was appointed on September 24th.

During March further concessions were given to other grades than enginemen, but the men were not satisfied, and eventually an application reached the National Wages Board which made an award on June 3rd. It gave the men in rural areas from 4s. to 7s. 6d. per week, and those in county districts from 2s. to 3s. 6d. each.

The Trenance Valley Railway was opened on May 1st, and on November 28th the London and North-Western began to convey the Irish mails by rail and sea throughout. There were two fatal accidents to passenger trains in 1920. In one five passengers lost their lives. It occurred at Lostock Junction on July 17th, when a driver started his train against his signal.

1921.—The outstanding event of 1921 was the passage of the Railways Act, 11 & 12 Geo. V., c. 55, which received the Royal Assent on August 19th. The further two years of control ceased on August 15th. The control of the Irish railways also ended on that date, but the Act did not extend to them, in view of the Government of Ireland Act, 1920, 10 & 11 Geo. V., c. 67.

On February 11th the report, Cmd. 1132, of Lord Colwyn's Committee on Railway Agreements was issued. Whilst it justified most of the claims of the railways it showed that some of the companies had been overreaching. The whole question was, however, disposed of by compromise, as the Railways Act voted the British companies sixty million pounds in settlement of all claims. A dispute arose with the North British as to alleged excessive claims. The correspondence was subsequently published, Cmd. 1162, and eventually the greater part of the deductions by the Ministry were allowed. The final report of the Advisory Committee on Electrification appeared in July. Therein direct current was recommended for all installations, but it was advised that the single-phase alternating-current system on the London, Brighton and South Coast be unaltered.

Without waiting for the date named in the Railways Act, the London and North-Western and the Lancashire and Yorkshire proposed to amalgamate as from January 1st, 1922. A scheme for that purpose was approved by the proprietors, and on December 20th was passed by the Railway Amalgamation Tribunal.

Signals given by coloured lights, by day as by night, were substituted for semaphores on the Liverpool Overhead Railway in April. It led to the appointment on July 27th, by the Ministry of Transport, of a Departmental Committee to consider the potentialities of light signals. Its report, dated October 28th, was issued on January 11th, 1922, and favoured the general adoption of day colour-light signals in

view of their greater utility and less cost of maintenance.

No new railways were opened and no extensions of note were made during the year. The accident record was the worst since 1915, as on January 26th two passenger trains met, "head on," at Abermule and thirteen passengers were killed. The collision was on a single line and was not due to any failure in the instruments, but to irregular working. It was the first collision on a single line in which passengers were killed since August, 1876. Three passengers lost their lives at Birmingham, New-street, on November 26th, owing to a signal being over-run. An accident which aroused considerable interest was a locomotive boiler explosion at Buxton on November 11th, where a safety valve did not act properly, owing, it was held, to the small amount of clearance between the valve webs and the seats when cold. The coal dispute of April, May and June completely upset all the calculations as to the railway receipts clearing off the deficit before the railways were handed back on August 15th. So serious was this matter that the point had to be argued whether control expired at the midnight of August 14th–15th or of 15th–16th.

1922.—The energies of the railway companies during the year 1922 were mainly centred on fixing up the arrangements for the amalgamation of twenty "constituent" companies into four large companies and the absorption by the latter of ninety-three "subsidiary" companies. By the end of the year the former scheme was accomplished, except with respect to the Caledonian, and only half a dozen or so of the subsidiary companies remained to be settled with.

On March 21st Waterloo Station, which had been under reconstruction and enlargement for many years, was formally opened. Another work that had been in hand for a long period—the widening between Chalk Farm and Queen's Park, including twin tunnels under Primrose Hill—was brought into use on July 10th. The Croxley Green branch electrification was completed on October 23rd.

On June 21st there appeared the report to the Ministry of Transport by the Departmental Committee, over which Colonel Pringle presided, which considered the question of automatic train control. Such a safeguard was considered quite practicable.

The Central and National Wages Boards which were set up by the Ministry of Transport in 1919 as a substitute for the conciliation scheme were confirmed by the Railways Act. The first award to be made by the latter under the new Act related to the wages and conditions of the men on the Scottish railways. The hearings began on January 11th and lasted seven days, and the award was made on the 24th *idem*. The companies did not get all they asked for, but they secured one main point—some of the absurdities of the eight hours' day for lightly employed men, like gatemen, were modified. It was further agreed that the special advances given in June, 1920—see above—should be withdrawn proportionately with the reductions in the sliding scale for the cost of living. On March 21st an agreement was made with the men that similar modifications should be made on the English railways. Railway Councils for the informal discussion of matters affecting conditions of service, &c., were established on April 3rd.

The opening bridge across the river Swale that gave railway and road communication with the Isle of Sheppey was damaged and thrown completely out of service on December 18th. Some reductions in freight rates were made in August. There were three fatal accidents during the year. In each of two cases one passenger was killed; the third, involving the death of three men, happened at Milton Range halt on August 21st, when a train started from Gravesend against the signal.

1923.—On January 1st passenger fares were reduced from 75 per cent. above to 50 per cent. above pre-war level, and in May and again in August reductions in freight rates were made.

In anticipation of the Football Association cup tie on April 28th at Wembley and the British Empire Exhibition of 1924, a new station on a circular loop was opened within what would be the Exhibition grounds, and the lines from Marylebone to Wembley were equipped with automatic signals, all of the day colour-light type. On November 19th the Charing Cross, Euston and Hampstead Railway was extended from Golders Green to Hendon, and on December 1st the Swale bridge, damaged on December 18th, 1922, was reopened. During the year the gravitational shunting yard at Feltham was completed, and the deepening of the inner harbour at Holyhead was concluded. From July 9th the 2.42 p.m. express from Gloucester to Paddington was timed to cover the 77 miles 24 chains from Swindon in 75 minutes, equal to an average speed of 61.8 miles per hour.

The National Wages Board, between November 8th and 16th, heard claims from the railway companies and the three railway unions. The award was published on December 20th, and whilst the men had their applications refused, the companies fared little better. The main point gained by the latter was a revision of the enginemen's conditions.

The remarkable safety of British railways was again evidenced during 1923. Only three passengers were killed in train accidents—two in one mishap and one in the other. An unusual incident, however, occurred on the City and South London Railway, which was under reconstruction at the time, on November 27th. The temporary workings were insufficiently protected against a percolation of water and a subsidence resulted.

1924.—The events of the present year may be summed up in their chronological order thus:—Although the representative of the Associated Society of Locomotive Engineers and Firemen had signed the above-mentioned award of the previous December, his union repudiated the award, and on January 20th there was a strike of enginemen which lasted until the 29th, when an agreement was arrived at to spread the increased day's run from 120 to 150 miles. The change came into force in three instalments. The last instalment of from 140 to 150 miles should be made in January next, 1925, and the enginemen threatened trouble should it be enforced. The companies, on their own initiative, expressed willingness to refer the matter to the National Wages Board, and it came before that Board on December 18th.

On March 21st a deviation at Coleraine, which allows the river Bann to be crossed at a better angle by a bascule lift bridge, was brought into use. The City and South London Railway was extended from Euston to join the Charing Cross, Euston and Hampstead Railway at Camden Town. The work, which involved some very interesting tube construction, was completed on April 20th. The former railway was reopened to Moorgate after its tunnels had been enlarged by about 18in. to the diameter of other tubes. The Harwich-Zeebrugge train ferry made its first trip on April 24th, and the Cuffley-Stevenage Railway was opened for passenger traffic on June 2nd. On August 18th the Golders Green line was further extended from Hendon to Edgware, and on December 1st the remaining portion—from Moorgate to Clapham Common—of the City and South London was reopened.

The Government announced on July 7th that it could not support the scheme for a Channel Tunnel. The Government of the Irish Free State having passed an Act for the amalgamation into one company of all the railways wholly in the Free State, the Irish Railway Tribunal on December 8th passed a scheme to carry the decision into effect. The new company will be known as the Great Southern (Ireland). During the second week of December the National Union of Railwaymen deposited with the companies an "all-grades programme."

There have been three fatal accidents to passenger trains during 1924. In a collision at Euston on April 26th five passengers were killed, and the same number lost their lives in one at Haymarket, Edinburgh, on July 28th. In a derailment at Warton, near Lytham, on November 3rd thirteen passengers were killed.

Literature.

Practical Microscopical Metallography. By R. H. GREAVES, D.Sc., and H. WRIGHTSON, B. Met. London: Chapman and Hall, Limited. 16s.

THE title of this volume leads the reader to expect a detailed guide to the practical side of microscopic metallography. Actually, the book is such a guide, but, as we shall show, it is something more. The practical instructions are no doubt based directly upon the authors' personal experience and practice, and although we may differ from Messrs. Greaves and Wrightson regarding the advisability of this or that detail and regret the omission of references to instruments and processes which we consider important, yet the series of really very fine photo-micrographs with which the book is illustrated serves to show that the results obtained by the authors are excellent, and that if the student can do as well under the guidance of this book he will do very well indeed. The practical side of the book, however, and even the series of micrographs, could have been made more complete and satisfactory had the authors contented themselves with that aspect of the subject. Instead of so limiting themselves, however, they have endeavoured to provide the student with food for metallurgical thought while engaged upon the tedious processes of metallographic laboratory work, and for this purpose their book includes a brief summary of the nature and constitution of steel and some alloys.

We doubt the wisdom of including the theoretical side of the subject in a handbook of laboratory instruction, mainly on the ground that there is not room for both in a book of the present size. The danger is that, at all events, some students will rely mainly or entirely upon what is contained in such a "compromise" book, with very unsatisfactory results. In most of their theoretical statements the authors are sound enough, but the difficulty is that brevity makes it impossible to be sufficiently clear and detailed to assure correct appreciation by a student reader. If, on the other hand, the student is also reading other books and, perhaps, attending lectures, he will have ample food for his thoughts if he wishes to keep them on metallurgical subjects while polishing his specimens.

In greater detail one may take exception in the first place to the treatment, in the practical section, of the functions of the metallurgical microscope and its illumination. The nature and functions of resolving power, which are so very important for metallographic purposes, are barely mentioned. Among the photo-micrographs Figs. 162 and 164 are distinctly below the high level of the book. On the theoretical or explanatory side of the book one may take exception to the statement of the melting point of pure iron as 1505 deg. Cent., when recent research has clearly shown that it is within a degree or so of 1530 deg. Cent. Then, a little further on, the banded structure often found in mild steel is ascribed to rolling at temperatures below A_3, while, in reality, it occurs in steel rolled at higher temperatures, and is derived from the original dendritic structure of the ingot.

While the book is thus open to both general and detailed criticism, it is undoubtedly a valuable addition to the still scanty literature of modern metallurgy. Students and even more advanced workers will find it very useful, and so long as they do not rely upon it as a general text-book of metallography, they are likely to get nothing but good from it.

The History of Firths. By A. C. MARSHALL and HERBERT NEWBOULD. Sheffield: Thos. Firth and Sons, Limited. 1924.

WE have received from Thos. Firth and Sons, Limited, of Norfolk Works, Sheffield, a history of the firm. The chapters appeared originally in *The Bombshell*, the house organ of the company, and they excited so much interest that it was wisely decided to reissue them in the form of a book. Messrs. A. C. Marshall and Herbert Newbould are the historians, and have done their work well. There is a human touch about it that is quite attractive. The authors are personally, even intimately, acquainted with many of the men who have made, or are making the firm, but they have skilfully managed to retain the feeling that they knew the founders almost as well as they do their successors. That, no doubt, springs from the fact that they have been able to get into touch with men who were in the firm almost at the start.

The firm was founded in 1842 by Thomas Firth and his two sons, Mark and Thomas. The father was a steel refiner with a fine reputation, engaged at the works of Sanderson Brothers and Co., whither he took the two boys, Mark to look after the commercial and Thomas the practical side. He himself earned 60s. a week, and his two sons 20s. each. But the boys were not satisfied, and young as they were—as was the manner in those days—started up on their own account in Charlotte-street. Apparently they brought their father over to them, but as the works were not opened till 1842 and he died in 1850, they did not have his valuable help for long. However, it endured long enough to put them on their feet, and they appear to have been young men of remarkable energy and push, for from a very early date we find them with agencies in various foreign cities. A year after the death of Thomas Firth, sen., a move was made from Charlotte-street to works which had been built in Savile-street. From that time onwards the history is one of steady progress and of constant benefits to Sheffield and to the kingdom. There has always been between Firths and its employees that human contact which it is so hard to maintain under modern conditions, and it is very pleasant to read in these entertaining pages of the real friendship which appears to have existed from the earliest days between the men and the management.

BOOKS RECEIVED.

Bituminous Sands of Northern Alberta. By S. C. Ells. Canada: Department of Mines. Price 25 cents.

Fuel. By J. S. S. Brame. London: Edward Arnold and Co., 41–43, Maddox-street, W. 1. Price 18s. net.

A New Chapter in the History of Permanent Way. By Sir Bradford Leslie. London: 171, Maida-vale, W. 9.

Electrical Technology. By H. Cotton. London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2. Price 12s. 6d. net.

Le Vol a Voile Dynamique des Oiseaux. By L. Breguet. Paris: Gauthier-Villars et Cie., 55, Quai des Grands Augustins (VI.). Price 8f. net.

Engineering Mathematics. Part II. By R. W. M. Gibbs. London: Blackie and Son, Limited, 50, Old Bailey, London. Price 1s. 3d. net.

Wills' Electric Lighting. Fifth edition. By John C. Dalton. London: Butterworth and Co., Bell-yard, Temple Bar, W.C. 2. Price 42s. net.

"Transactions" of the Institution of Naval Architects. Volume LXVI. Edited by R. W. Dana. London: Henry Sotheran and Co., 43, Piccadilly, W. 1.

Electrical Measuring Instruments. Part II. By C. V. Drysdale and A. C. Jolley. London: Ernest Benn, Limited, 8, Bouverie-street, E.C. 4. Price 55s. net.

The Testing of High-speed Internal Combustion Engines. By Arthur W. Judge. London: Chapman and Hall, Limited, 11, Henrietta-street, W.C. 2. Price 25s. net.

Machine Design, Construction and Drawing. Fifth Edition. By H. J. Spooner. London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 21s. net.

Die Windführung beim Konverterfrischproze B. By Dr. Ing Hayo Folkerts. Berlin: Julius Springer. Price 13,20 Goldmark.

The Discharges and Levels of the Nile and Rains of the Nile Basin in 1919. By P. Phillips. Cairo: Government Publications Office, Ministry of Finance, Dawâwin. Price P.T. 5.

Some New Sewage Treatment Plant and Apparatus.

BY the courtesy of Mr. W. H. Makepeace, the borough sewage engineer of Stoke-on-Trent, we recently visited the Hanley sewage works at the invitation of Messrs. Hartley, Sons and Co., of Stoke-on-Trent. Our visit was primarily for the purpose of inspecting at work a demonstration bio-aeration sewage treatment plant designed by that firm, which has recently been put to work there, but advantage was also taken of the occasion to witness in operation two types of water-wheel-driven sewage distributors of Messrs. Hartley's latest design.

The bio-aeration treatment plant, all the details of

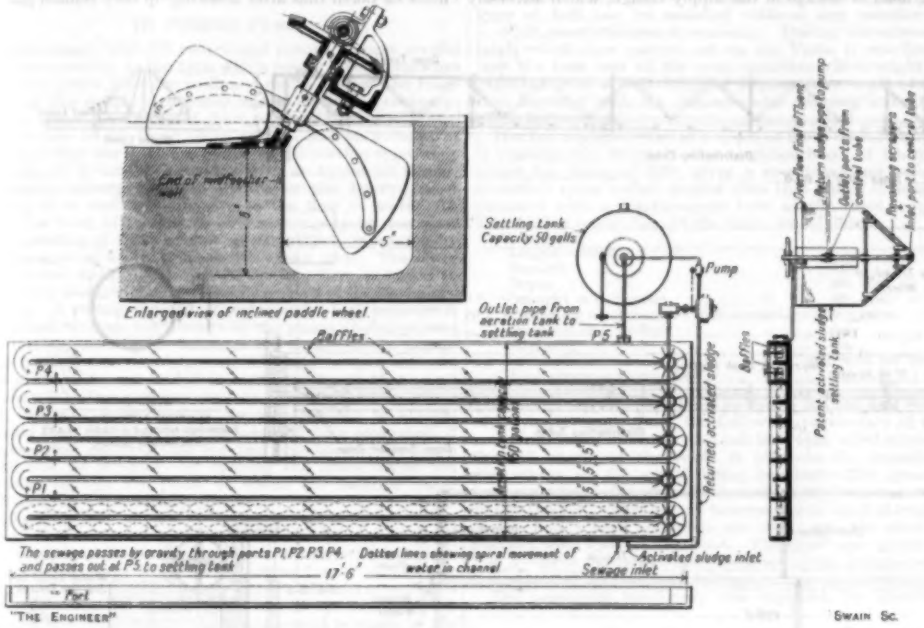

Enlarged view of inclined paddle wheel
Baffles
Settling Tank Capacity 50 galls
Pump
Outlet pipe from aeration tank to settling tank
Overflow final effluent
Return sludge pipe to pump
Outlet ports from central tube
Sparking scrapers
Inlet port to central tube
Patent activated sludge settling tank
Returned activated sludge
The sewage passes by gravity through ports P1, P2, P3, P4, and passes out at P5 to settling tank
Dotted lines showing spiral movement of water in channel
Activated sludge inlet
Sewage inlet
17'6"
"THE ENGINEER"
SWAIN Sc.

FIG. 4—HARTLEY BIO-AERATION PROCESS DEMONSTRATION PLANT

which have, we understand been patented, possesses many points of interest. It is the result, so we are informed, of four years of careful research work, and a close study of the previously introduced methods of treatment, the main objects kept in view being that (*a*) the sewage during treatment should be thoroughly agitated and aerated by frequent exposure to the air; and (*b*) that the power expended should be as small as possible. The system eventually evolved embodies the following features:—

(1) A combination of the "stage" process—*i.e.*, a process embodying a series of separate tanks through which the liquid being treated passes in succession, as contrasted with the "endless" system in which the liquid is continually circulating in sinuous channels in one tank—with a mechanical means of circulation;

(2) Each "stage" tank consists of two long adjacent channels connected at each end by a U channel so as to form one endless channel;

(3) An inclined paddle wheel fixed in one or both U bends of each "stage" tank for propelling the liquid along and around the endless channels forming each tank;

(4) Independent means for aerating and mixing the liquid and maintaining the activated sludge in suspension throughout the endless channel forming each tank; and

(5) A specially devised settling tank which, it is claimed, it is possible to keep almost clear of settled sludge, while the sludge return is kept up to 80 per cent. after two hours' settlement.

A drawing of the experimental plant at Hanley is given in Fig. 4. It will be observed that the aeration tank consists of five separate "stage" tanks which are themselves provided throughout nearly the whole of their length with a centrally arranged dividing wall, so that each comprise a closed channel. At one U bend in each "stage" tank there is an inclined multi-bladed propeller which imparts continuous motion to the liquid and circulates it round the channel. A small port in the side wall in each of the first four of the "stage" tanks affords a means of communication between the tanks, so that the liquid can pass from one to the other in succession. These ports are indicated by P_1, P_2, P_3 and P_4, while P_5 shows the outlet through which the treated liquid passes to the settling tank. It is claimed for the inclined paddle wheel that it has an efficiency, as a water propeller, which it is impossible to obtain with any vertical paddle wheel unless it has such a diameter that it would be impracticable to employ it. For example, it is asserted that, to give an equal effect to that produced by an inclined paddle wheel 11ft. 6in. in diameter, a vertical paddle wheel would have to be approximately 57ft. in diameter. Messrs. Hartley assure us, in fact, that they have demonstrated by exhaustive model tests that for propelling water along open channels their inclined wheel gives results which are 50 per cent. better as regards expenditure of power than the best results obtainable with a vertical paddle wheel of the same diameter.

The paddle wheel is not depended upon alone, however, to keep the mixture of sewage and sludge constantly agitated. Messrs. Hartley discovered, after numerous experiments, that if vertical plates dipping well down into the liquid and arranged at an angle inclined to the direction of linear flow were fixed in the channels at regular intervals, the effect was to give the sewage a rotary spiral motion as it flowed in the channels. This rotary motion is plainly visible in the demonstration plant, and so efficient was it found to be in keeping the sludge in suspension and in continuously bringing the particles of sludge to the surface, and hence into contact with the air, that it was discovered that the linear velocity of the flow in the channels could be reduced from 90ft. to 30ft. per minute without any tendency for the sludge to settle, while at the same time there was a rapidly changing surface throughout any number of tanks having channels of any length up to 300ft.

The possibility of reducing the rate of linear flow in this manner has an important effect. Using the Weisbach formula for the friction of water in pipe bends, Messrs. Hartley estimate that in propelling water along channels of the form in question with small radius bends at each end, approximately 75 per cent. of the total power is absorbed, at the bends. Let us put this into actual figures. Supposing that a plant requires, say, 40 horse-power to propel a certain volume of sewage along its channels at 90ft. per minute. Then 75 per cent. of that 40 horse-power—or 30 horse-power—is absorbed in the bends. Then, since the power absorbed is as the cube of the velocity, twenty-seven times less power—or only 1.1 horse-power—will be required at the bends if the rate of flow be only 30ft. per minute. The power saved on the straight by the linear flow of 30ft. per minute is partially offset by the baffles fixed at intervals of, say, 25ft. along all the channels to create the spiral mixing, aerating and cleansing flow of the sewage. Messrs. Hartley state that the power absorbed by the baffles, is theoretically, approximately equivalent to halving the area of the tank, which means a double velocity of 60ft. per minute. Since 10 horse-power is absorbed in the straight with a linear flow of 90ft. per minute, then 3 horse-power will be absorbed at 60ft. per minute, so that the total theoretical horse-power absorbed by a plant of the type proposed by Messrs. Hartley would only be 1.1 + 3 = 4.1, as compared with the original 40 horse-power. Messrs. Hartley inform us that these theoretical savings have been confirmed by experiments with falling weight tests which they have made. It was upon the figures thus obtained that Mr. Makepeace advised his Committee to install the small demonstration plant which we saw in operation.

Turning once more to Fig. 4, it may be explained that the sewage, which is as a fact effluent from a detritus chamber, is introduced into the first channel at the point indicated in the right-hand bottom corner of the drawing, and that activated sludge pumped from the settling tank is introduced through another inlet closely adjacent to it. It may here be explained that the combined capacity of the five aeration tanks is 150 gallons, that the length of the channels is 18ft., and that the channels measure 5in. square. The capacity of the settling tank is 60 gallons. The paddle wheels make 37 revolutions per minute and have an average mean velocity of 74ft. per minute when the linear velocity of flow in the channels is 30ft. per minute.

Soon after the experimental plant was installed by Mr. Makepeace and put into operation it was found that a considerable quantity of sludge was being permanently retained in the settling tank, the bottom of which is sloped at 47 deg. to the horizontal, and that portions of that sludge became septic and rose to the top of the tank and adversely affected the efficiency of the latter. To remedy this difficulty a stirring device having two arms which rested lightly on the sloping inside of the tank was installed and made to revolve once in fifteen minutes. The effect was that an 80 per cent. sludge return was obtained, that only 3 per cent. of the total sludge was retained in the settling tank, and no trace of sludge rose to the surface as long as the scrapers were at work. There is in the tank a central rotating tube, up which the sludge is drawn by the action of a pump and passed out through ports into a horizontal pipe which communicates with a closed chamber surrounding the central tube. This arrangement leaves the bottom of the tank free from pipe obstructions, so that the scrapers can be revolved without hindrance.

The plant, since its installation at Hanley, has been carefully tested under practical working conditions by Mr. Makepeace, who has, so we are informed by Messrs. Hartley, given much valuable advice and assistance throughout the experiments. As the result of his investigations we gather that he has decided to install a full-sized unit as part of a new aeration plant which he is designing for the Stoke and Fenton sewage.

We may add that the demonstration plant was started to work continuously on September 27th last and in nine weeks built up its own sludge from the Hanley detritus effluent without the introduction of any sludge or humus from outside sources. The volume of detritus effluent dealt with has been steadily increased up to a dry weather flow of 450 gallons per day; that is to say, three times the contents of the aeration tanks. We understand that while treating that quantity the final effluent has been quite up to the high standard required for the borough of Stoke-on-Trent, and Messrs. Hartley aver that they have reason to believe that the plant is capable of dealing with a still greater dry weather flow. A sludge volume of not less than 20 per cent. after two hours' settlement has been main-

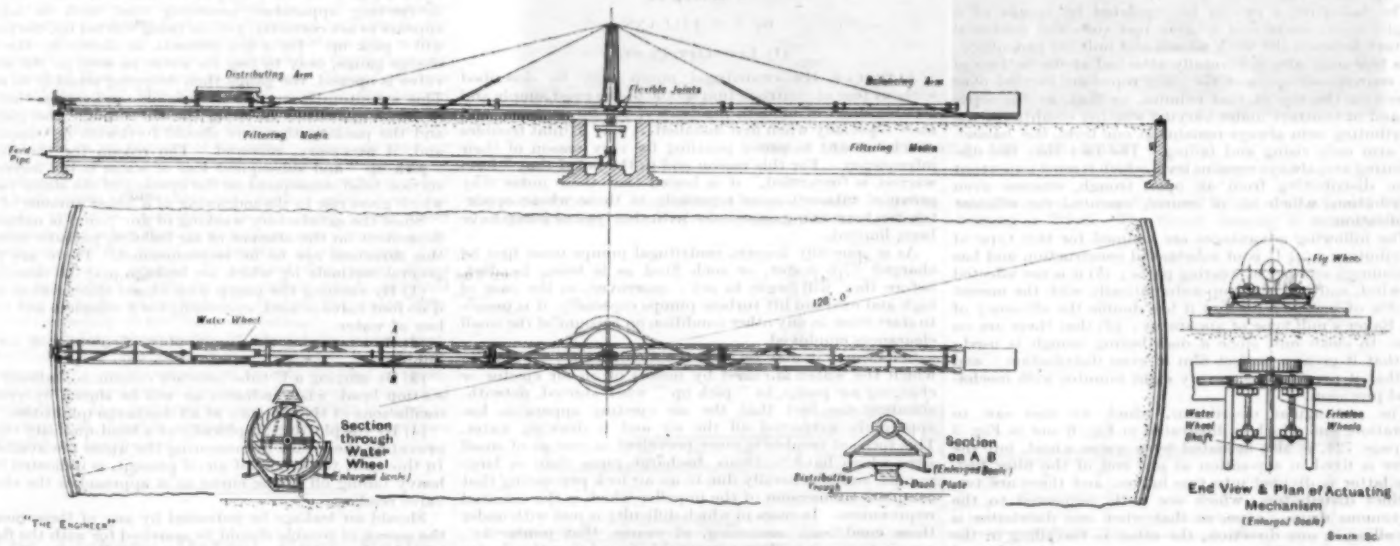


FIG. 5—WATER-WHEEL-DRIVEN BALANCED ARM SEWAGE DISTRIBUTOR FOR CIRCULAR BEDS

tained in the aeration tank, while the plant has been working continuously.

While at the Hanley works we saw, as mentioned above, a large water-wheel-driven circular distributor, which is also of Messrs. Hartley's manufacture. It is illustrated in Fig. 5 herewith and in Fig. 1 on page 726. It is working on a filter bed of 128ft. diameter and is revolving at the rate of once in eight minutes. It distributes from one arm only, the other arm simply acting as a balance. The water-wheel, which is shown separately in Fig. 2 on page 726, is carried centrally over the distributing arm and is operated by the sewage carried from the central column through a tube which is supported by brackets above the distributing trough. The sewage descends from the water-wheel into the distributing trough below and passes in opposite directions to both ends of the trough, which has an open top, so that the cleaning of the jet holes along the bottom is quite easy. These jets, it may be explained, impinge on dash plates, which disperse and aerate the sewage, which falls on the filter bed in the form of a continuous film from end to end of the distributing arm, the amount actually distributed from the numerous jets being proportioned to the diameter of the bed being traversed. The water-wheel shaft is extended to the outer circular wall, where it rotates by frictional contact two-track wheels attached to and overhanging the end of the distributing arm, as is shown in one of the larger scale drawings on Fig. 5. The track wheels rest and drive upon a circular rail upon the wall.

The balancing arm can be regulated by means of a weight at its outer end to give just sufficient frictional contact between the track wheels and rails for propulsion. This balancing arm is pivotally attached at the bottom of the central column, and the sling ropes are carried over rollers on the top of that column, so that, as the ropes expand or contract under varying weather conditions, the distributing arm always remains at one level, the balancing arm only rising and falling. The fact that the distributing arm always remains level, which is most important when distributing from an open trough, ensures even distribution, which is, of course, essential for efficient purification.

The following advantages are claimed for this type of distributor:—(*a*) It is of substantial construction and has a minimum number of wearing parts; (*b*) it is not affected by wind, and will start up automatically with the merest dribble of sewage; (*c*) that it has double the efficiency of the Baker's mill type of apparatus; (*d*) that there are no pipes to clean out, since a distributing trough is used; (*e*) that it gives a perfect film of even distribution; and (*f*) that it revolves once every eight minutes with mechanical precision.

The rectangular distributor, which we also saw in operation, and which is illustrated in Fig. 6 and in Fig. 3 on page 726, is also actuated by a water wheel, but the latter is fixed in a position at one end of the filter bed. The latter is divided into two halves, and there are two distinct distributors, which are both connected to the continuous driving rope, so that when one distrbutor is travelling in one direction, the other is travelling in the other direction. The two are, therefore, entirely balanced against air pressure, so that the strongest winds do not affect their accurate working.

The advantages claimed for this method of driving the distributors, in addition to this balancing, are several. For instance, the weight of the distributors is reduced as compared with that of those which carry their own wheels and gearing. Then, again, the supply trough, which runs from end to end of the filter bed, is reduced in height, since only just sufficient head of sewage for distribution is required, the additional head necessary for operating water wheels on the distributors themselves from the supply trough being dispensed with.

The distributors are reversed at the ends of the beds by means of two bevel wheels, which mesh into a crown wheel and are thrown into and out of gear alternately by each distributor in turn, as it approaches the end of the bed. The ropes drive from a drum, which is rotated by the water wheel and form a double rope pull at each end of each distributor arm, as with the firm's power-driven distributors, which we described in our issue of February 22nd last, and it is claimed for them that they have all the advantages of the power-driven rectangular distributors and that with a head of sewage of 3ft. 6in. they will travel at 25ft. to 30ft. per minute. They are, moreover, not held up by severe frost or light falls of snow, since they are hauled and not driven by friction of the wheels on the rails.

An interesting feature in the design of this distributor is that there are dual syphons and distributing tubes. Each syphon has a specially designed valve, and both are automatically opened and closed at the ends of the beds for intermittent distribution. Either valve may be made to operate for intermittent or continuous distribution, or may be shut off altogether independently of the other, so that by this means the distribution may be varied in the ratios of 1, 2, 3 and 4 without the necessity of a lowering head of sewage in the supply trough, which adversely affects the spraying of the jets. The makers point out that this type of distributor is suitable for quite small schemes, as well as for large ones, and that spans up to 60ft. wide may be used if necessary.

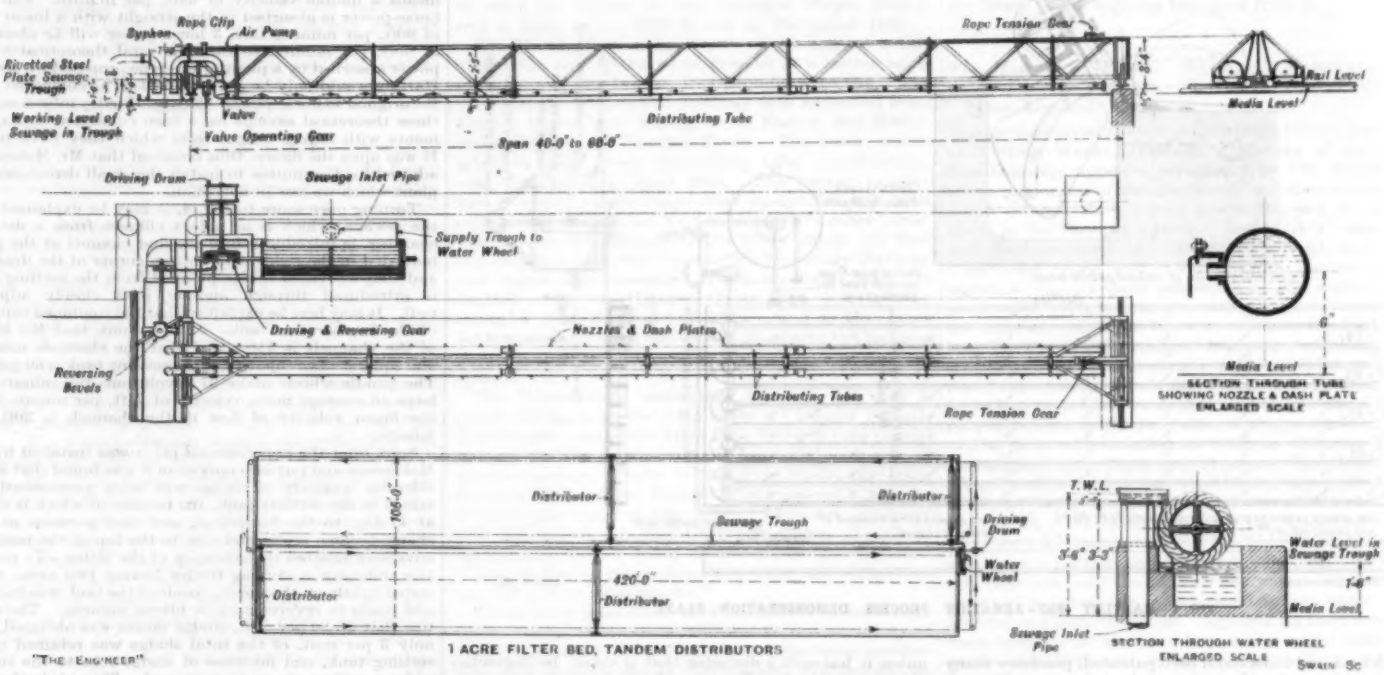


FIG. 6—WATER-WHEEL-DRIVEN SEWAGE DISTRIBUTOR FOR RECTANGULAR BEDS

The Operation of Centrifugal Pumps.

By J. S. PILLANS.

(1) LOW-LIFT PUMPS.

ALTHOUGH the centrifugal pump may be described without fear of contradiction as one of the most simple and reliable units of modern machinery, yet on occasion, and more especially when first installed, it may exhibit troubles which are apt to prove puzzling by very reason of their infrequency. For this reason and in the belief that "forewarned is forearmed," it is hoped that these notes may prove of interest, more especially to those whose opportunities for gaining experience with this type of pump have been limited.

As is generally known, centrifugal pumps must first be charged with water, or such fluid as is being handled, before they will begin to act; moreover, in the case of high and medium lift turbine pumps especially, it is unsafe to start them in any other condition on account of the small clearances employed.

Sometimes it may be found difficult to get a pump, in which the water is raised by means of an air ejector or charging air pump, to "pick up" when started, notwithstanding the fact that the air ejecting apparatus has apparently extracted all the air and is drawing water. This form of trouble is more prevalent in pumps of small sizes which have tortuous discharge pipes than in large pumps, and is generally due to an air lock preventing that complete submersion of the impeller which is the essential requirement. In cases in which difficulty is met with under these conditions—assuming, of course, that joints, &c., are air-tight—it is almost invariably found that the ejector is incorrectly placed on the pump. It is impossible, on account of the wide diversity in the types and arrangements of pumps to lay down any hard and fast rules as to the proper positions of ejector connections, since every case requires individual consideration; but, in general, it may be said that the ejector must be connected to the highest part of the pump casing, or in some cases both to the rising main and to the pump casing. If it be borne in mind that the object is to submerge the impeller, common sense will generally indicate the proper position for the connection or connections. The present tendency, where low-lift pumps are employed, is to keep them "drowned" where circumstances permit, on the principle of the "bore-hole" pump, and to drive them from above by vertical spindle motors or turbines, through intermediate shafting. In this way, of course, charging considerations are entirely obviated, and the pump is at all times ready for immediate operation.

Where pumps have a suction lift, however, either the ejector or air pump previously referred to must be used, or where the branches are of fairly small diameter it is frequently more convenient to fit a foot valve to the suction pipe and thus maintain the pump continuously full of water. When this arrangement is adopted, trouble arising from a partially submerged impeller is practically impossible, as the air cock, usually fitted to the highest point of the volute, may be used as an indicator for the presence of a complete fill of water.

Pumps which are provided with water-sealed glands should be run so that a continuous trickle of water is obtained externally from the glands, as, although at first sight liable to give an impression of incorrect adjustment, by so doing the packing is kept cool and well lubricated, and assurance is given that air is not being drawn past the glands into the pump. The glands themselves should be tightened until they run very slightly warm, and care must be taken that after screwing up they remain parallel to the shaft, thus avoiding the possibility of scoring the latter. Especially is it necessary that the glands of pumps which are not water sealed should be kept well tightened up, as the effect of air being drawn past the packing may cause a greater reduction in the output of the pump than the average engineer would expect. Moreover, the impeller blades are liable to rapid erosion or corrosion in the event of long-continued air leakage. The foregoing remarks on glands are equally applicable to turbine as well as to ordinary pumps. It may sometimes occur, when a pump has been long in commission, that while the air-ejecting apparatus—assuming that such is used—appears to act correctly, yet, on being started up, the pump will "pick up" for a few seconds, as shown by the discharge gauge, only to lose its water as soon as the sluice valve is opened, the gauge then dropping steadily to zero. This symptom is an almost infallible indication that air in large quantities is being drawn through the glands, and the packing therefore should forthwith be examined and, if necessary, renewed. The reason for the initial "pick up" and subsequent loss of water is the increased suction head consequent on the opening of the sluice valve, which gives rise to the indrawing of a larger amount of air.

Since the satisfactory working of any pump is naturally dependent on the absence of air leakage, periodic tests in this direction are to be recommended. There are four general methods by which air leakage may be detected:

(1) By running the pump with closed sluice valve, and, if no foot valve is used, examining for a complete and rapid loss of water.

(2) By examining the pump efflux, if submerged, for air bubbles.

(3) By affixing a U tube mercury column to indicate the suction head, when indrawn air will be shown by violent oscillations of the mercury at all discharge quantities.

(4) By the plotting graphically of a head-quantity curve, providing the means of measuring the water are available. In this case, the intake of air, if present, is indicated by a heavy falling off in the curve as it approaches the closed valve reading.

Should air leakage be indicated by any of these means, the source of trouble should be searched for with the flame of a candle, applied systematically to all joints, flanges, fittings and glands on the suction side of the pump. In certain cases quantities of air may be drawn in through vortices forming in the water round the suction pipe, a phenomenon commonly known as "piping." The depth of the submersion of the suction pipe in such a case as this appears to be immaterial within fairly wide limits, and the writer on one occasion discovered a pump of quite moderate size which was consistently drawing air in this manner, although the bottom of the suction pipe was 6ft. below the surface of the water. The only remedy for trouble of this nature lies in sufficiently reducing the intake velocity of the water into the suction pipe by increasing the effective area, either by the addition of "bell mouths," "umbrellas," or tee-pieces, or by drilling holes in the submerged portion of the pipe.

Pumps which are not provided with suction strainers are sometimes liable to pick up an object which may become wedged in the impeller, causing a serious diminution in the output of the pump, even if not actually fouling

the casing. Pieces of wood and sacking seem to be the chief offenders in this direction, although on at least one occasion a 6in. dial steam gauge was found to be firmly wedged in the impeller blades of a large circulating pump, without, strange to say, causing further damage than a temporary reduction in the output of the pump.

Although, of course, definite proof that the impeller is clear of obstruction can only be obtained by examination, yet very frequently a good indication may be obtained from the behaviour of ammeter, wattmeter or Venturi meter, when the plant includes one or more of these instruments. Since the obstruction will be closing a segment of the impeller to the passage of water, it will thereby give rise to an unbalanced disc, which may frequently be detected by regular oscillations of the ammeter and wattmeter pointers, and the mercury column of the Venturi meter in all cases this oscillation will be found to synchronise with the speed of rotation of the pump.

(2) TURBINE PUMPS.

Multi-stage, high-lift centrifugal pumps possess several features peculiar to the type which render them somewhat less fool-proof than the ordinary pump. Since the function of the multi-stage pump is the forcing of comparatively small quantities of fluid against discharge heads, which may be anything up to 4000ft., and on account of the fact that the discs are of the single suction type, they are almost invariably provided with an hydraulic thrust-balancing arrangement to neutralise the heavy forces acting in a direction opposite to the flow of water. A common form of the device in question may be described as consisting of two circular opposing discs, separated by a clearance of a few thousandths of an inch. The outer of the two discs, in relation to the impellers, is keyed to the pump shaft, whilst the other forms part of the stationary casing. A certain amount of water under high pressure is admitted between the discs from the pump discharge, and by forcing them apart balances the thrust of the pump. The balance water having done its work, escapes between the discs, and must be led to waste by a path that at all times will be free and unrestricted. Since the balancing of the thrust is dependent on the maintenance of a sufficiently high discharge head to keep the discs separated, it is absolutely essential that the discharge head of the pump shall not be reduced—by opening the sluice valve too widely—beyond the point at which the balance water will issue in a free steady stream.

Charging and impeller obstruction troubles are infrequent with turbine pumps, as it is almost universal practice to equip their suction pipes with combined foot valves and strainers, together with a charging funnel for priming by means of an external water supply. Should it be necessary, however, to charge by means of an exhauster or ejector, the connection of the latter should be made to the top of the casing of the first (low-pressure) stage. By so fixing it, the first stage impeller may be fully charged with water, and the arrangement will invariably be found to give satisfactory results for starting purposes. Furthermore, it has the advantage of eliminating any possibility of danger from water at high pressure finding its way into the air-extracting apparatus, should the isolating valve inadvertently be left open when the pump is running, this being a possible contingency if the connection is made to the final stage casing. It should be mentioned that the connecting of the air-extraction pipe to the discharge branch, apart from the possibility of danger previously referred to, is generally useless for charging purposes, as air locks caused by the stages will prevent the impellers being more than half-charged with water.

It is becoming increasingly common, more especially for mine drainage, to couple turbine pumps to high-speed alternating-current motors, and the well-known starting characteristics of the latter, in particular of the squirrel-cage type, render it important that the main sluice valve at the pump discharge be kept fully closed until the motor has run up to speed. Under this condition, the power required to drive the pump at full speed is approximately one-third of that necessary at full load. Should starting be attempted with the sluice valve open to the normal working extent, it will usually be found that the motor will fail to run up to speed or will be seriously overheated should it do so, on account of the greatly increased starting torque required.

Although turbine pumps may be run at normal speed and with closed sluice valve with perfect safety for short periods, yet it is inadvisable to run them under these conditions for more than two or three minutes at a time, on account of the rapid overheating of the water with which they are charged. To prevent this, many sluice valves are provided with by-pass valves which, together with the balance water leak-off, change the water sufficiently frequently to prevent overheating.

In concluding these notes, it should be added that, notwithstanding the somewhat formidable list of precautions and possible sources of trouble detailed in them, yet in practice centrifugal pumps are inherently simple and trouble-free. It is just because there is so little in them to go wrong that possible sources of trouble are sometimes neglected or overlooked.

The Fishery Patrol Boat Vaila.

IN a Journal note of September 18th we gave a brief account of the fishery patrol boat Vaila, a new type of fast motor cruiser, which has been specially designed for the coast service of the Scottish Fisheries Board. By the courtesy of her designers and her builders we are now enabled to give some further details of this interesting and novel high-speed vessel, which has, we understand, undergone exhaustive trials with conspicuous success. The Vaila was designed by Mr. Norman Hart, of Kingsbury House, St. James', London, and it may perhaps be best described as a boat having a stepless hydroplane hull, with the weight and draught of a craft of the displacement type. It is claimed that such a combination of features is valuable in that it renders possible more comfortable accommodation and seaworthiness, and at the same time permits of a speed and running economy which has not previously been attained.

As our readers are doubtless aware, the high ratio of horse-power to displacement has always proved a serious problem in the case of craft which are required to plane, and for this reason designers have been in the past naturally slow to take responsibility for turning out boats of the hydroplane type with scantlings fully up to those used in a displacement type of hull of the same size. In fact, we are informed that there was a general belief that such boats, if designed, would not plane. From this point of view the illustrations reproduced in Figs. 1 and 2 are of considerable interest, for they show the Vaila planing at full speed and the characteristic wake with small disturbance.

It appears probable that the combined type of hull we have referred to will, whether built in wood or steel, become increasingly prominent during the next few years, when it is once realised that the demand for higher speeds than those which can be obtained with the displacement type of hull can be satisfied without any sacrifice of comfort, seaworthiness or economy. During the extensive trials which were carried out on the Vaila, it was found that the boat had all the good qualities which might be expected from a well-designed displacement craft of her size, together with the characteristic stiffness and speed of the hydroplanes.

Her full draught, even at a speed of more than 16 knots, is considerable, being in the neighbourhood of 4ft. 6in., whilst her beam of 12ft. gives a steadiness and accommodation space rather greater than that which is usually obtained with a displacement boat of the same length. The leading particulars of the Vaila are as follows:—

Length overall	55ft.
Breadth	12ft.
Depth	6ft. 6in.
Draught at full speed	4ft. 6in.
Propelling machinery—Triple-screw Gleniffer motors	
Diameter of cylinders	6in.
Stroke	8in.
Speed of motors	800 revs. per min.
Total power at above speed	300 B.H.P.

The hull of the ship was built by Hugh M'Lean and Sons, of Govan, Glasgow, and the following particulars of the scantlings are of interest. An oak keel 4½in. sided extends the full length of the boat; it protects the propellers and allows of the vessel being beached. The ground frames are 2in. sided, also of oak, and are twelve in number, whilst the 2½in. sided engine bearers extend the full length of the hull. Teak coamings are used, and the deck is planked with 1¼in. yellow pine. The drawings—given in Fig. 3—serve to indicate the character of the accommodation provided and the deck fittings.

The propelling machinery was supplied by Gleniffer Motors, Limited, of Anniesland, Glasgow, and it comprises a centre cruising motor of the company's standard six-cylinder type, with reversing gear, and the firm's patented vaporiser for using paraffin. An aluminium crank case and reversing gear casing are used instead of cast iron, as in the standard model, and, we learn, reduce the weight of the complete engine by about 8½ cwt.

The wing motors are also six-cylinder models designed to use petrol, and again aluminium crank cases and pistons are used. No reverse gears are required on the wing motors, but a fly-wheel friction clutch and thrust bearing is fitted. The thrust bearing is mounted on a bracket on the crank case, and it takes not only the propeller thrust but also the starting thrust of the propeller when the engine is not running and the propellers are

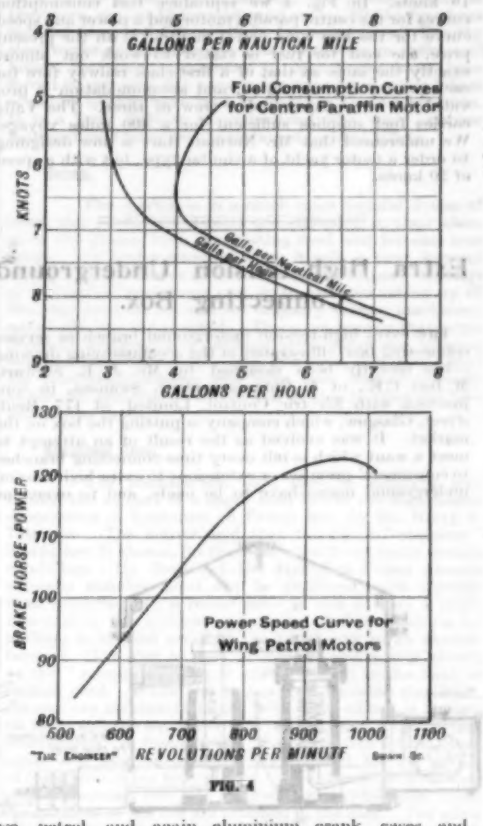


FIG. 4

FIGS. 1 AND 2—THE VAILA AND HER WAKE

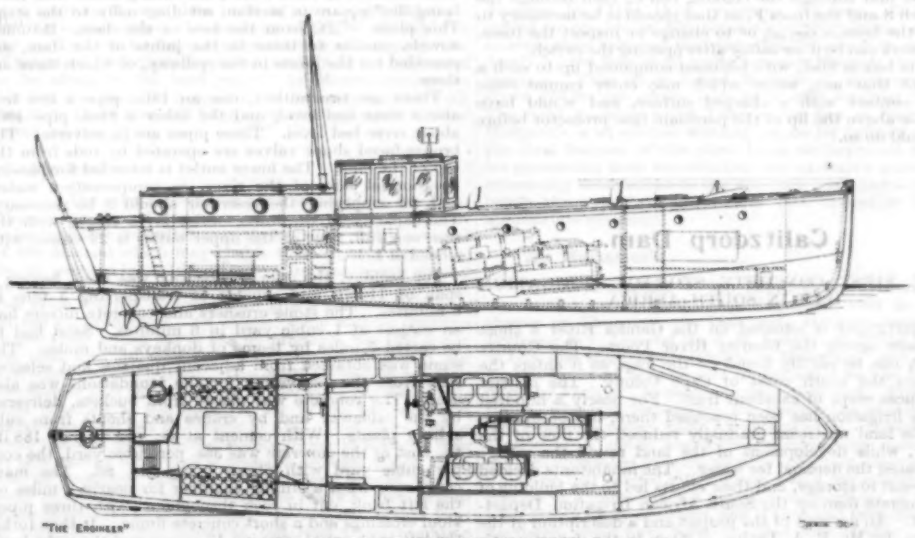
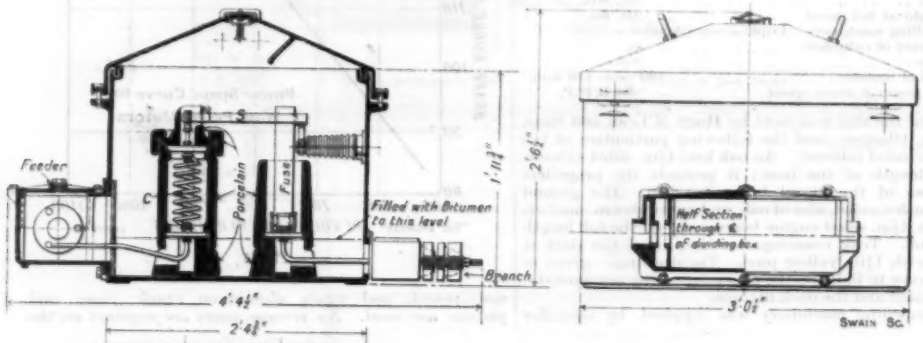


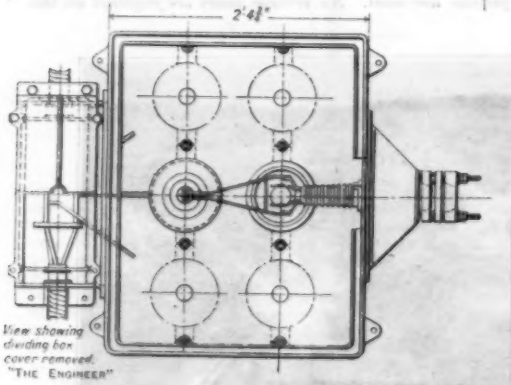
FIG. 3—THE FISHERY PATROL BOAT VAILA

idling. When the boat is under way the wing engines are started by throwing in the friction clutches. The cruising speed of the Vaila with the centre unit only in operation is 8 knots and the full speed with the three units 16 knots. In Fig. 4 we reproduce fuel consumption curves for the centre paraffin motor and a power and speed curve for the two wing petrol motors. With the present price, the cost for fuel is stated to work out almost exactly the same as that of a first-class railway fare for each person accommodated, and accommodation is provided for two officers and a crew of three. The Vaila carries fuel supplies sufficient for a 400 miles voyage. We understand that Mr. Norman Hart is now designing to order a motor yacht of a similar type, but with a speed of 20 knots.

Extra High-tension Underground Connecting Box.

THE extra high-tension underground branch or service connecting box—illustrated in the accompanying drawing—has recently been designed by Mr. J. E. Stewart, M. Inst. C.E., of 3, Gloucester-place, Swansea, in conjunction with Electric Control, Limited, of 177, Reid-street, Glasgow, which company is putting the box on the market. It was evolved as the result of an attempt to meet a want which is felt every time connecting branches to consumers' premises or extensions to extra high-tension underground mains have to be made, and to overcome





HIGH-TENSION CONNECTING BOX

the difficulties encountered with such mains especially when faults or interruptions occur through the fault of the consumer.

It is claimed for the box that it embodies within a relatively small space all the features which can be adopted for overhead branches, and that the branch from the mains can be made without cutting the mains.

The drawing makes the arrangement so clear that but little description is necessary. The branch circuit is made, first through the choking coil C, then through the switch S and the fuses F, so that should it be necessary to test the branch circuit or to change or inspect the fuses, the work can be done safely after opening the switch.

The box is filled with bitumen compound up to such a height that any water which may enter cannot come into contact with a charged surface, and would have to rise above the lip of the porcelain fuse protector before it could do so.

Calitzdorp Dam.

THE FIRST CONCRETE STORAGE IRRIGATION DAM IN SOUTH AFRICA.

CALITZDORP is situated on the Gamka River a short distance above the Gouritz River Poort. The Gouritz River can be readily found on the map, as it enters the sea on the south coast of Cape Colony. The district produces crops of excellent fruit. For nearly a hundred years irrigation has been practised there, but occupation of the land upstream gradually reduced the flow of the river, while development of the land round the village increased the demand for water. The inhabitants decided to resort to storage, and their efforts led to the building of a concrete dam by the South African Irrigation Department. An account of the project and a description of the works, by Mr. P. A. Taylor, is given in the department's *Magazine*, September, 1924, from which the following particulars are given, some comment on points of special interest being interpolated.

The Gamka River drains a large part of the Great Karroo as well as a part of the Zwartberg, this range of mountains having a rainfall up to 30in. a year on the peaks, though the average at Calitzdorp is less than 12in. The capacity of the reservoir at full supply level is 205 million cubic feet, and the amounts of water passing the site of the dam in the years 1912 to 1917 inclusive were, respectively, 391, 434, 555, 205, 373, and 757 million cubic feet, an average of 452 millions. In most years, therefore, there will be a large amount of water not impounded. The spillway has been designed to discharge 11,900 cusecs with 5ft. depth on the sill. The freeboard is 2ft. to the top of the corbel of the crest and 4ft. if the height to the top of the panels of the parapet be added. With the water level at the top of the corbel the discharge would be about 19,000 cusecs, with the panels giving an emergency freeboard of 2ft. Taking the area of "70 odd square miles" as being 75, the estimated high flood, 11,000 cusecs, corresponds with a coefficient of 431 with the Dickens formula, or 618 with the Ryves formula; the weir discharge with 5ft. depth corresponding with the coefficients 407 and 608 respectively, the latter figure being somewhat less than South Indian precedent suggests, namely, 675. If, however, we take the normal coefficient for the Dickens formula, 825, we obtain the estimated figure of nearly 21,000 cusecs; and, in the Ryves formula, the coefficient of 1000 recently employed and suggested by experience in countries other than South India, the result is nearly 17,800 cusecs. It seems very unlikely, therefore, that the level of the reservoir will ever rise above the corbels.

The dam is founded on solid quartzite. It is of mass concrete, 6 : 2½ : 1, with 20 per cent. of large stones as "plums." The volume is 63,000 cubic yards. The crest length is 700ft., the maximum height above river bed 100ft. and above foundations 112ft. The greatest width at the base is 74ft. The crest is 8ft. wide in the solid, with corbels, and the parapet is of the pillars and panels type. The corbels are 1ft. above the solid crest and monolithic with it, the tops of the panels being 2ft. higher. The upstream face of the dam is vertical, the downstream face having a slope of 1¼ to 1 to within 17ft. of the top, and thence a steep batter. A noteworthy feature of the cross-section is the vertical upstream face, an unusual feature for a dam of this height, though very small batters are usual. The spillway is 330ft. wide—waterway—and discharges down steps into a contour tail race on the right bank. This tail race is 5ft. wide at the upper end, widening to 50ft. where the water passes the end of the dam, the slope from this point being 1 in 50, changing to 1 in 35 about 100ft. downstream. The tail race is cut out of the fissured quartzite of the hillside, and is provided with a cut-off wall 330ft. long and 10ft. thick, carried down in some places more than 40ft. into water-tight rock.

The air temperatures of the locality range from 22 deg. Fah. to 120 deg. Fah. and, accordingly, contraction joints have been provided both in the dam and in the spillway. There are five such joints in the dam, about 100ft. apart, extending from foundation to crest. The joints are formed by smooth abutting surfaces with three stanching elements, 2ft. 6in. apart. Two of these are bitumen dowels 6in. wide lengthwise of the dam, of dice-box section, 4in. thick at the edges and 3in. at the throat in the joint. The third element is a copper plate, 12in. wide, fixed between two-ply bitumen sheets, the edges being sealed with bitumen in each recess, the enlargement thus filled being 3in. square in section, set diagonally to the strip. This plate is 2ft. from the face of the dam. Bitumen dowels, similar to those in the joints of the dam, are provided for the joints in the spillway, of which there are three.

There are two outlets, one an 18in. pipe a few feet above river bed level, and the other a 24in. pipe 40ft. above river bed level. These pipes are in culverts. The bronze-faced sluice valves are operated by rods from the top of the dam. The lower outlet is intended for passing the normal flow of the river, as compensation water, and for emptying the reservoir should it be necessary. The capacity of the lower outlet is 75 cusecs with the reservoir full, that of the upper outlet is 22 cusecs with a head of 1.7ft.

For building the dam a cableway was used, having a span of 1100ft. and capable of transporting 3 tons in 6 minutes. The stone crushers and concrete mixers had an output of 1 cubic yard in 6 minutes. Sand had to be carted 5 miles by teams of donkeys and mules. The stone was obtained from adjacent quarries and selected stuff from the excavation for the foundations was also used. The concrete was placed from buckets, delivered by the cableway and by cranes and shoots from subsidiary plants. With cement at 8s. per bag of 188 lb. the cost of the concrete was 36s. per cubic yard, the cost per cubic yard with plums being 31s. 8d. The main canal runs from a stilling chamber for nearly 2 miles on the left bank, cut in rock throughout, with three piped kloof crossings and a short concrete flume. It then forks, the left bank canal carrying 12 cusecs and the right bank channel, supplied through an 18in. siphon, 8 cusecs. Below this point there are three road crossings, with pipes in deep cuttings under the roads; 12 pipe kloof crossings, 7 siphons, and several "flood escapes." The left bank canal is about 13 miles long and the right bank canal 9 miles, both reaching the boundaries of the irrigated area, and having slopes of 1 in 2500 except at crossings. The area previously irrigated was 373 morgen, or 790 acres, and the new canals command an additional gross area of 2180 acres, of which 1393 acres can probably be irrigated.

A very useful analysis of costs is given. The total cost was £168,000, including land, £9870 and roads £3672. The total engineering cost of the irrigation works, including administration and general charges, £13,500, was £154,500. The dam and spillway cost £123,800. The engineering costs total and the items are, therefore, roughly in the proportions; total 100; dam, 67.3; spillway, 6; canals, 11; miscellaneous—administrative and general, 9. The rates for rock excavation were:—Foundations of the dam, 4s.; for the spillway, 4s. and 3s. per cubic yard. It may also be noted that, at full supply level, the reservoir contains about 1200 cubic feet per £1 of the engineering expenditure. The whole cost, in terms of the new irrigable area, is nearly £120 per acre. Without deducting losses by evaporation and absorption, the relation between the volume of water stored above the upper outlet and the area of irrigable land is 192.6 million cubic feet and 1393 acres, or a depth of 3ft. of water.

Australian Engineering Notes.

THE Federal, Victorian, South Australian, and New South Wales Governments have approved of the proposals of the recent conference regarding the construction of the Hume Reservoir. The resolutions, which have been approved by the above-named Ministries, were that provision should be made for outlet works at the Hume Reservoir suitable for hydro-electric generation; that the cost of such additional works, estimated at £40,000, should be borne in equal shares by the Governments of New South Wales and Victoria, which Governments should have the sole use of any power generated at the reservoir; that the work of construction of the Hume Dam, of sufficient dimensions to provide for a reservoir of 2,000,000 acre-feet, should proceed for a period not exceeding three years, and that the question of the ultimate capacity and completion of the reservoir be then the subject of a further conference of Ministers representing the four contracting Governments.

* * * * * *

THE New South Wales Premier stated recently that approximately 92 per cent. of the contract price of the North Shore Bridge would be spent in Australia. All material except steel plates would be produced in Australia. Steel plates to be imported were valued at £348,000, and the balance of the contract price, amounting to £3,873,921, would be spent in Australia.

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THE New South Wales Railway Commissioners are inviting tenders, closing February 18th, for the supply of four three-phase, 25-cycle, 500 kVA transformers.

BITUMEN IN ROAD CONSTRUCTION.

OFFICIAL support for the scheme for the foundation of a Chair of Highway Engineering at London University will, we understand, probably be forthcoming from the Asphalt Roads Association, the majority of the leading members of which are already closely interested in the Paviors Company's proposals. While the important programme of research work planned by the Association will, of course, be carried out quite independently, the close identity between the main objective of the Association and the general purpose of the proposed University faculty, suggests that some degree of co-operation might be desirable.

The Association, which has offices at 40, Broadway, London, S.W. 1, has as its primary function the development along scientific lines of the use of bitumen as a matrix in road construction. Its research and technical work will be directed towards (*a*) the evolution of new and improved methods of asphalt construction of various forms, and the solution of practical problems that may arise; (*b*) the more effective regulation of bituminous road work by the formulation of improved standard and special specifications and the simplification and co-ordination of sampling and testing methods; (*c*) the study of foundations and subbases, and of aggregates for use in asphalt; and (*d*) the comparative costs and values of different types of construction in relation to the conditions encountered on roads of all classes. The results of this work will be made freely available to highway engineers and others in any way interested in road construction, to all of whom the Association will accord technical information, advice and facilities in connection with construction work of any description.

Numbering among its controlling members a majority of the leading British authorities on bitumens and asphalts, the Association invites the co-operation of county and local authority road officials, who are being enrolled as associate members. The funds of the Association will be wholly devoted to the furtherance of those objects of experiment and research, and the collation, collection and dissemination of information and statistics, which inspired its foundation.

COMPLIMENTARY DINNER.—On the 20th inst. the senior staff of the Yorkshire Electric Power Company entertained Mr. W. B. Woodhouse, the engineer and manager of the company, at a complimentary dinner in honour of his recent election as president of the Institution of Electrical Engineers, Mr. J. J. H. Stansfield, the secretary of the company, being in the chair. In proposing the health of the guest of the evening Mr. Stansfield referred to the long and varied experience which Mr. Woodhouse had had of the electrical industry in all its branches and to the interest he had taken for many years in the Institution, both in Yorkshire and in London. Mr. Woodhouse joined the staff of the Newcastle Electric Supply Company in 1899, and four years later was appointed to take charge of the Yorkshire Electric Power Company.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

Christmas Holidays.

Of business in the Midland iron and steel trade this week there has been practically nil, both producers and consumers having settled down to enjoy the Christmas vacation in readiness for the strenuous work of stocktaking and the overhauling of their plant and resources preparatory to the trade which is hoped for, and confidently anticipated, in the New Year. Very little rolling, if any, has been done in this district this week, practically all the works being closed down. Business, therefore, is being held up until the New Year, and hopes are high that buying will then develop on a fairly large scale. Undoubtedly, the iron and steel industry will benefit considerably from the very substantial railway programmes of reconstruction and re-equipment recently announced. Midland and Staffordshire mills expect to be called upon to supply large quantities of iron and steel for rolling stock construction, and local engineers anticipate a fair share of the constructional work. Many things have contributed during the past three months to a return of industrial confidence and manufacturers' spirits have risen accordingly. The outlook for the year 1925 has become increasingly promising. The past year has been a trying and anxious one for Midland industrialists, and in the heavy steel trades, and the Staffordshire finished iron industry, there has prevailed much depression, and works have suffered through the intermittent working of plants especially designed for large production. Considerable trouble has been caused by continued ferment in the labour world and that constitutes the black spot on the 1925 horizon. It is sincerely hoped that with signs of the turning tide of trade labour will act reasonably and that disputes will be settled without resource to strikes and lockouts.

Market Position.

Expectations of improved buying of iron and steel in the New Year are such as to maintain the general level of prices, and what little business has been done during the week has been on the basis of recent quotations. The only exception is in the case of mild steel billets, where values have fallen as the result of the sudden change in the outlook for the tin-plate trade. Welsh billet makers have offered supplies at as low as £7 per ton, but consumers' immediate requirements being satisfied, little, if any, advantage has been taken of these offers.

Trade Situation.

The trade returns for the past month give encouragement to the hope that the iron and steel industry is again moving forward. In November imports were down and exports were up. From August onward the amount of partly manufactured and finished material purchased from competing nations had been increasing, with disturbing regularity. In November there was a sharp decline, due, however, to more stringent conditions on the Continent, rather than to any considerable transfer of demand to the home producer. Whereas imports in October totalled 241,328 tons, value £2,110,197, the November returns, covering two fewer working days, gave 213,002 tons, value £1,805,666. A large tonnage of forge and foundry pig was imported, but there was a much more considerable decline in the foreign basic pig that came in. In blooms, billets and slabs the shipments were still heavy—58,645 tons—though not quite so heavy as in October. In other leading categories the figures were lower. The increased exports of pig iron in October were not quite maintained in November. While our overseas trade in finished materials took a variable course, there was substantial improvement in some departments, November being the best month since July.

Railway Engineering.

The additional expenditure on home railways comes at an opportune time. It is to the export trade that the rolling stock firms ordinarily look as the mainstay of their trade, and at present they are getting very inadequate orders from foreign markets. It is not to be supposed that these outlays on the part of the leading home railways which have been foreshadowed will be proceeded with immediately in their entirety, but the contracts made with outside firms for rolling stock are an earnest of what other industrialists may expect. Deliveries of the wagons required will begin early in the New Year, and will go on for six to nine months. At the moment many of the Birmingham wagon works have excellent contracts on their books, in some cases insuring full work until the autumn. Very little contracting has, as yet, been done for rails, though many thousands of tons are understood to be involved in the scheme.

Steel Houses.

A great deal of interest is being taken in the Midlands and Staffordshire in the Government projects for the encouragement of the use of steel in house building. This is a matter of great importance to the steel works, as the most powerful plant, having large capacity, is well suited for the production of the steel plate which will be called for in such structures. This enterprise may prove to be of great value to the trade if such houses become popular, and the various schemes now being considered fructify. Many Midland local authorities are experimenting with a view to erecting large numbers of steel houses if it is deemed advisable in the light of such experiments.

Black Country Industries.

The end of the year finds many of the Black Country industries in a much improved position, and there are prospects of increasing activity in the New Year. The various branches of engineering continue to show a healthy forward movement. The tube trade, which has been under a cloud in this district for a long time, is now getting along better, orders coming through more freely. The electrical machinery trade continues fairly good, the export business being quite a feature. In the stamping industry the home trade has been picking up for some time, following a spell of quietness. The present indications are that things will improve further, but competition for business remains very keen. Foreign markets continue to be quiet, due to the activities of continental and American makers. Structural engineers, at the moment fairly quiet, are getting useful inquiries which should eventually bring good lines to the mills, though these will take time to develop. Heavy edge tools continue to find a brisk trade overseas, but the busy season is now on when merchants have to buy in for the spring planting season. Motor engineering is keeping up well, the demand being in excess of most manufacturers' recent anticipations.

Fewer Unemployed.

The weekly statistics of unemployment show that for the week ended December 15th the number of unemployed persons in the Midland area was 136,973, as compared with 139,362 the previous week, a decrease of about 2400. In the Birmingham area there has been a decline of 756, the aggregate dropping from 29,966 to 29,210. Short time workers are 206 less, the total standing at 926.

LANCASHIRE.

(*From our own Correspondents.*)

MANCHESTER.

Iron, Steel and Metals.

THE markets this week are very quiet and dull on account of the holiday season, and one finds very little business passing on the Manchester Exchange. Instead of actual business to produce cheerfulness there is a very favourable anticipation of what is going to occur next year, and, in spite of the present idle markets, people are very bright and optimistic, and the general feeling seems to be that we are getting away from the bad years and into a period of more normal trading conditions. The mere belief in this may be sufficient to make markets better in the opening of the year; but one cannot help thinking that the feeling is far too sanguine. There are many difficulties still in the way of a return to normal trading and normal industry, not only here but throughout Europe; but in this country especially one main difficulty lies in the fact that the cost of production is very much too high.

Metals.

The markets for all the non-ferrous metals are very firm and are generally thought to be in a promising condition. Naturally actual business is restricted, but the optimistic feeling is very obvious, and even in the absence of much buying by consumers the market has an active appearance. The movements in the sterling-dollar exchange have been against an advance in copper, but in spite of this the market has been firm, and the tendency amongst operators to speculate for a rise is more obvious. Even the more cautious of the merchants have been expressing the opinion that copper will be dearer in the New Year. Perhaps a note of warning ought to be sounded now so that undue speculation leading to an extravagant rise in prices may be checked. The fact is that a moderate rise in copper may probably occur, and may reasonably be sustained; but any extravagant rise in the present circumstances would be suicidal madness. We may probably trust the American copper magnates to see this and to put a stop to extravagances. There is a very large margin for the expansion of copper production, and anything like really high prices would bring in a lot of new metal. The consuming trades are improving, but they are not yet very robust, and ought not to be subjected to a flood of supplies. If the market can be kept from extravagances, then £2 or £3 per ton may be added to the selling prices of copper. A favourable view of tin is also taken in this market, based mainly upon the fact that consumers of tin must now rely upon the current production. At the moment, however, this production seems rather more than equal to the needs of the market. Of course, if there should be a spurt in the tin-plate trade or even in general engineering consumption, the position might be altered. In the markets for lead and spelter there is still a good deal of optimism; but there are many people who are beginning to be afraid of the lead prices. In Manchester up to £44 10s. was paid for a small lot of foreign pig lead. All our ideas about lead will have to be revolutionised if these prices are to prevail.

Pig Iron.

The markets here for pig iron are quiet but firm. There is no sign of weakness anywhere, and sellers seem to be confident that after next week there will be a renewal of the demand which may enable them to raise prices by 1s., or perhaps by 2s. 6d. Derbyshire makers are aiming at 85s. per ton in trucks at the furnaces, and say that this price will not do more than give a fair remuneration on the pig iron itself. Of course, some makers contrive to get a fair return out of the by-products, but this is not the case with all, and they naturally contend that pig iron ought to pay for itself. One doubts, however, whether Derbyshire iron can be put up to 85s. while Northamptonshire is selling at less than 77s. 6d. at the furnaces, and while Cleveland can be bought at 81s. That there will be some increase in the actual consumption of foundry iron in this district next year is probable enough, but it must not be forgotten that the ironfounders bought largely early in November, and may not be ready to buy largely again so soon as the year opens. Scotch iron is firm here at 107s. 6d. per ton delivered, but East Coast hematite is rather weak at slightly under 101s.

Finished Material.

There is no sign of improvement in the demand for Lancashire bar iron, and the trade is dull and depressed. One does not see what is to happen in the future unless Lancashire iron can be brought down nearer to the price of steel. In the market for sectional steel there seems to be a rather more hopeful feeling; but prices remain as they were, viz., at £9 for joists and angles, £9 15s. for plates and flat bars, and £10 to £10 7s. for round bars. The big steel works at Parkgate are again beginning to make acid billets, for which consumers in Manchester have been forced to pay over £11 per ton for some time, while billets of rolling quality have been available at about £8 per ton. It is a little difficult to understand why such extreme figures should have been maintained for acid billets.

Scrap.

The market is in a much more hopeful frame of mind this week, and dealers are stiffening in their ideas as to the prices, both for melting steel and for cast iron scrap. For heavy wrought there is only a poor demand owing to the idleness at the Lancashire forges. Holders of fine textile machinery cast scrap are now asking up to 90s. delivered for it; and for ordinary broken machinery metal 85s. per ton is asked. There are reports that some Sheffield consumers of melting steel scrap are offering 80s. and 82s. 6d. per ton; and, of course, this means that the Lancashire dealers who have been buying recently at 62s. 6d. and 65s. on trucks will be able to clear out at a substantial profit.

Stainless Iron.

The manufacture and uses of stainless iron formed the subject of a paper read before the Manchester Association of Engineers on Friday last, by Mr. Harry S. Primrose. The author said that the name "stainless" was rather ill-chosen, for the metal would rust under certain conditions. He described the Hamilton-Evans process whereby stainless steel can be produced more cheaply than hitherto. In a recent note in this column I made reference to this interesting process, which commences by melting mild steel scrap in the usual way in an electric furnace. The slag is then poured off and a slag known as the "reception" slag is introduced on to the bath of molten steel. When the slag is in a suitable condition, chrome ore intimately mixed with ferro-silicon is thrown on to it, and the entire body of the ore, with its refracting components, is fused, while the chromium oxide, iron oxide and manganese oxide are reduced by the action of the silicon in the ferro-silicon. The chromium and other metals descend into the molten metal while the other components of the ore are retained in the slag. The silica resulting from the oxidation of the silicon combines with the lime in the slag, and the basic lining is thus protected from excessive corrosion, while the resulting slag, after reduction has taken place, acts as a refining agent for the molten metal. It is necessary that the chrome ore should be as rich as possible in chromic oxide and iron oxide in order that the minimum quantity of slag may be produced. It is claimed that by means of the Hamilton-Evans process ingots can be produced at £30 per ton, as compared with £65 per ton for mild stainless steel ingots made by the ferro-chrome process.

Some Interesting Engineering Work.

A few days ago I had an opportunity of inspecting several really interesting jobs which have recently been completed by Scott and Hodgson, Limited, Guide Bridge, near Manchester. They include an electrically operated driving gear of the American type for a sheet-rolling mill, which are said to be amongst the first constructed in this country, and the largest that have hitherto been attempted. The plant is intended to drive normal loads of 5000 horse-power, peak loads of 10,000 horse-power, and occasional peak loads of 15,000 horse-power. The power is transmitted through huge double helical gears made by the Power Plant Company, Limited, the large wheel being 17ft. diameter and 4ft. on the face. This is claimed to be the largest double helical gear wheel that has ever been undertaken in this country. The gear ratio is 8 to 1. The whole of the gearing is enclosed and is lubricated by oil supplied in jets at the points of contact of the wheel and pinion, and the main bearings are fitted with both pressure and ring lubrication. A second example of the firm's recent construction consists of a high-speed flywheel set for use in conjunction with Ilgner apparatus for balancing the load for electrically-driven rolling mills or for colliery winding, and consists of a wheel 12ft. diameter by 17½in. thick, weighing 36½ tons. It is designed to revolve at 600 revolutions per minute, and is so accurately balanced that the wheel is caused to revolve slowly by the flow of oil under pressure through the main bearings. This oil is forced through at a pressure of about 150 lb. per square inch by a self-contained pump. The third machine which I saw under test at Scott and Hodgson's is an electric winding engine for colliery work; the chief features of the plant being an improved device for preventing both overwinding and excessive speed—an interesting attachment to the governor machanism which brings the powerful band brakes into operation at the appropriate moment.

The Mechanicals.

At a meeting of the North-Western Branch of the Institution of Mechanical Engineers, held in Manchester on Thursday, the 18th inst., the two papers by Professor F. C. Lea and Mr. J. M. Lessells, on "The Effect of Low and High Temperatures on Materials," and "The Elastic Limit in Tension and its Influence on the Breakdown by Fatigue" respectively were discussed. Professor Haigh, who was responsible for reading an abstract of Mr. Lessells's paper, took advantage of the occasion to contribute a most instructive commentary upon the subject, illustrated by some photographs from experiments which he had carried out. There was a stimulating discussion of Professor Lea's paper, some portions of which were pretty freely criticised, and if time had permitted the discussion could have been extended considerably.

Manchester College of Technology.

To celebrate the centenary of the Municipal College of Technology, the Lord Mayor of Manchester—Alderman F. J. West, M. I. Mech. E., held a reception

at the college on Friday last, when an address was delivered by the Earl of Crawford and Balcarres. The laboratories and workshops were thrown open to the guests. In the weaving laboratory of the textile department a demonstration of the process of weaving was given, and in another department the processes of letterpress, lithographic, and offset printing and the linotype and monotype processes of mechanical composition for letterpress printing were shown. Examples of the work done were presented to the guests as souvenirs of the centenary. During the evening the Lord Mayor referred to the proposed extensions of the college, which are to be carried out at a cost of a quarter of a million pounds. Towards this sum £120,000 has already been promised, and £60,000 has been paid. The Lord Mayor expressed the anticipation that the Manchester Corporation would provide the balance of the money required. He said that there was every prospect that Manchester would keep ahead in the field of technical education. The Earl of Crawford, in an admirable address on the history and objects of the College of Technology, said that elsewhere technical education was looked upon as a right, but in Manchester so great was the scope, so varied the objectives, so remarkable the equipment, and so efficient the staff, that he hoped it would be treated rather as a privilege. He said the college had still great duties to perform, duties more onerous than ever, and he was convinced that those responsible for the government of the institution would face those obligations with courage and determination.

BARROW-IN-FURNESS.

Hematite.

The hematite pig iron trade is gradually improving, and the number of inquiries is increasing. Makers are experiencing a better condition of things than for some time past. Orders for forward delivery are coming in, and the output in the district is pretty well taken by customers, who are more inclined to hold small stocks than they were. It will take some time before trade can be called brisk, but in the meantime the tone is good, and one can view the future with a certain amount of optimism. Regarding output, much depends upon the state of the steel trade. If the sheet departments can be kept going with orders, then the amount of iron that they will take will considerably affect the number of furnaces that will have to be put or kept in blast. The continental trade is not big at present. A cargo went to Antwerp last week, the vessel which took it having brought billets from Ghent. America is taking more iron, and two part cargoes were dispatched last week for Philadelphia and New York. No doubt the regular service of freight steamers between Barrow and New York and Philadelphia is fostering a better trade in pig iron.

Iron Ore.

The iron ore trade is slightly improved. Apart from local demands, which total a fairly heavy proportion of the output, better trade with customers outside the district is being experienced. There was dispatched last week a part cargo of ore to Antwerp. Spanish and other foreign ores are in slightly better demand.

Steel.

The steel trade is just moderate, with two rail mills working, but both requiring fresh orders to keep them running. The first consignment of steel rails for New Zealand was loaded at Barrow last week in a Shaw Saville steamer, the tonnage being 5000. The hoop and small section mills are experiencing a fair trade.

Holidays.

It is a sign of better times that Vickers, Limited, are only closing down a few days for the holidays. They cannot afford any delays on present contracts.

SHEFFIELD.

(From our own Correspondent.)

Heavy Steel Trade.

THE billet mills and open-hearth furnaces have been closed down for the holidays. The length of the stoppage will depend upon the state of trade, but it is expected that it will be of a fairly long duration. Up to the time of closing down the acid departments were busier than the basic, but both were experiencing the quietude usually associated with this period of the year. About the middle of December there came something in the nature of a sharp slump after a period of brisker buying, and though some producers were rather hard pushed to get orders, and were indeed not averse to giving concessions here and there, a feeling of depression did not descend on the market. There have been reasons for believing that the opening of the New Year will see a gradual revival of trade. The buyers of crude and semi-finished steel expect to be busier, and as they have brought their stocks down to the lowest possible point for the year-end stocktaking, they should be more prominent in the market as soon as they are certain of their own position. Although the feeling is one of optimism, there have been so many disappointments lately that all those interested in the iron and steel trades are proceeding with the utmost caution. In the event of the usual holiday stoppage being extended all the men who lose work in consequence will be granted unemployment relief.

Manufactured Steel.

With signs of improvement in other manufacturing centres the makers of finished steel are anticipating an increased flow of orders. The railway companies have announced programmes which so far involve an expenditure of nearly £45,000,000. Most of this money is to be spent on the renewal of rolling stock, permanent way and bridges, and in view of the great quantity of steel required Sheffield is bound to benefit. Prospects in the shipbuilding trade are also more promising, and the result of all these developments should be orders for Sheffield castings, forgings, tool steel, tools and files, and all other classes of steel requisites. Sheffield interests are closely identified with certain firms which have secured recent railway contracts. The railway plants of Sheffield are capable of enormous and rapid production and a great deal more work can be accommodated. The home railway companies have done their best, but private wagon owners are now almost out of the market owing to the recent new specifications which involve increased cost, and the export market is nothing like what it should be. It is at this point that foreign competition has to be met. Indian work is difficult to get, but at the moment there is a fair number of orders in course of execution for the South American railways.

Cammell Laird's Report.

In their annual trade report on railway carriage and wagon manufacture Cammell Laird and Co., Limited, state that "the steel carriage and wagon industry, which depends mainly on exports to foreign countries, has been sadly handicapped by the fact that wages here are higher and working hours shorter than those ruling with our competitors on the Continent. As a natural result of this and the desire of continental firms to obtain work at any sacrifice prices have touched a very low mark. In many cases indeed the British manufacturer has found it impossible to include in his tender more than a very small proportion of overhead charges, and it has therefore been the rule rather than the exception for contracts to be taken at below cost of production. Such conditions, representing, as they do, a highly abnormal state of affairs, have been extremely trying to British manufacturers, and it is great relief to note indications of an improvement at last. Inquiries for rolling stock are becoming more numerous again and prices show a tendency to rise. The prospect also of stable government for some years to come should certainly help to revive that feeling of confidence without which no industry can prosper."

A Repeat Order.

After delivering from their Nottingham works forty-one steel motor coaches and forty trailer coaches for the London Electric Railway, Cammell Laird have received a further order consisting of twenty-five control trailer coaches. These will be built during the early part of 1925. The first part of another important contract—for the supply of steel coaches to the Great Indian Peninsula Railway Company—has just been completed. Thirteen motor coaches and thirty-nine trailer coaches, all 68ft. long by 12ft. wide, have been shipped to India. The remainder of this order, consisting of twenty-five motor coaches, 68ft. long by 10ft. wide, is not required until 1925. During the year considerable progress has been made in the development of the "Sentinel-Cammell" coach, built in conjunction with the Sentinel Waggon Works (1920), Limited, which supplies the engine and boiler. Orders have now been secured for three two-compartment "Sentinel-Cammell" steam rail coaches for the Ceylon Government Railways, two coaches for the London and North-Eastern Railway, one coach for the Northern Counties (Ireland) section of the London, Midland and Scottish Railway, a coach for the Entre Rios Railways, South America, and one rail coach for the Haienosand-Solluftea Railway, Sweden.

Plate and Cutlery.

The plate and cutlery trades have had a fairly good season, and most of the works will be quiet for some weeks after the Christmas holidays. There is still a fair amount of work in hand for cheap case goods, the sale for which is steady during most of the year. Large quantities have gone away for the Christmas trade, and there has also been a big demand for the best grades of stainless cutlery. This season, also, there have been better trade conditions for silver and the highest qualities of electroplate. Although the seasonal rush has been of shorter duration than was the case in more prosperous times, the volume of trade generally has been satisfactory.

Cast Iron Houses.

Rotherham Corporation has accepted as an experiment the offer of the Tenter Foundry Company, Masborough, to construct two cast iron semi-detached houses. The tenders for the two amount to £840 gross, but the subsidy grant will have to be taken off, which will make the cost to the Corporation £640 for the pair. Mr. Potter, of the Tenter Foundry Company, states that he regards cast iron houses as a solution of the problem of house shortage for working people, and incidentally a help towards relieving unemployment in the iron trades.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Outlook.

ALTHOUGH much has yet to be accomplished before anything like a normal state of industry is reached there are unmistakeable signs of improving trade, and that in the near future activity at the works in the North of England will be considerably increased. The outlook is certainly brighter now than at any other period for the past two years. Confidence is being restored in commercial and industrial circles, as is shown in the preparations that are being made to re-start idle plant early in the New Year. The South Durham Steel and Iron Company expects to be ready in January to begin producing galvanised corrugated sheets from its new department, which is at the moment in process of completion at its Malleable Works, Stockton. The full capacity of the plant which has been put down is 700 tons per week. There is an excellent market just now for galvanised sheets, particularly abroad, and the company expects that most of its output will be exported.

Cleveland Iron Trade.

While at the moment of writing business is almost at a standstill consequent upon the Christmas holidays, the condition of the Cleveland iron trade is much more healthy than it has been for many months past, and it is confidently believed that the turn of the year will witness a further expansion of output and an approach to a wider measure of activity than has been experienced for a long time past. There is every reason to anticipate a good steady home trade, as Cleveland pig iron is about the cheapest in the country, while the export position shows signs of improving. Rising costs of production on the Continent are narrowing down the price margin, but it is still true that with the advantage of a depreciated exchange French, Belgian, and German producers can offer pig iron at a lower price than British producers. However, many continental consumers prefer the better quality British pig iron, and a fair number of export inquiries is coming forward. Prices are steady, No. 1 Cleveland foundry iron being 86s. 6d., No. 3 G.M.B. 81s. 6d., No. 4 foundry 80s. 6d., and No. 4 forge 80s. per ton.

Hematite Pig Iron.

There is little change of moment to note in the condition of things in the East Coast hematite pig iron trade. Stocks in makers' yards are still heavy, but they are being gradually liquidated to augment the present output, which is going steadily into consumption. Mixed numbers are unchanged in price at 88s. per ton, and No. 1 at 88s. 6d.

Ironmaking Materials.

The foreign ore trade continues dull and featureless. Long contracts are the rule in this trade, but so far there has been little movement in the direction of covering requirements over next year. Sellers are quoting 22s. 6d. per ton for best Rubio ore, c.i.f. Tees, but consumers decline to entertain this price, which they consider too high. Good medium blast-furnace coke is steady at 25s. per ton delivered at the works.

Manufactured Iron and Steel.

Most of the steel works in the North of England have closed down until the first Monday in the New Year, and there is little movement in the market. The outlook, however, is regarded as encouraging. Prices are firmly maintained.

Shipbuilding Output.

Returns to hand show that the shipbuilding output on the Tyne during 1924 was much greater than that of the previous year. It aggregates sixty-five vessels of 274,557 tons, as compared with forty-five vessels and 154,058 tons in 1923, an increase of twenty vessels and 120,499 tons. The output on the Tees was the biggest since 1920. As against thirty new ships built in 1923, seventy-two were launched in 1924, and the gross tonnage was 185,182, as against 75,570.

The Coal Trade.

The position in the Northern coal trade is somewhat irregular. In the Northumberland steam coal section, for example, merchants have covered the bulk of requirements for a fortnight ahead, and are not pressing supplies on the market; yet, although supplies on offer are limited, the undertone rather favours buyers, best steams being obtainable at 18s. 6d. per ton. The output of steam smalls is rather in excess of requirements and prices are easy. On the other hand, the Durham gas coal trade is brisk and prices have hardened considerably. This is no doubt due to the probable effect of lack of output during the holidays, for the pits will be idle for fully a week altogether. Otherwise it cannot be said that values have shown any real advance. The current high prices are regarded as of a temporary character, and there is nothing at the moment which would seem to promise their continuance after the occasion for them has passed away. Inquiry from abroad is certainly rather better, but next year's contracts have not been subjected to any real test. The news that the Malmo Gasworks has contracted for gas coals from Germany in preference to those of Durham has caused a feeling of disappointment in the Northern market and an unsettled view as to the trend of events over the early part of next year. The contract amounted to 10,000 tons for delivery to Malmo between January and June, and it is understood that the prices tendered by German merchants were considerably below those of Durham merchants. A fair amount of activity is reported in the bunker coal trade, both for prompt and forward, and prices are firm at 18s. 6d. to 20s., according to grade and delivery dates. The coke trade shows no improvement, and revival of demand is not noticeable.

SCOTLAND.

(From our own Correspondent.)

"Slowing Down."

THE approach of the holidays has been marked by a slowing down in markets generally, business throughout the past week being on a very restricted basis. There has been no rush for supplies of any particular class or description of material usually experienced at this season. Some works have orders to clear off before closing down, but the majority proceed quietly.

More Optimism.

Interest in markets has been chiefly concerned with prospects for the ensuing year. The general tone on 'Change is more optimistic. On all hands the opinion is held that the worst is over, and a slight improvement in both home and export inquiries gives a degree of justification for such sentiment. A greater amount of confidence is certainly permeating industrial circles, and the New Year is hopefully anticipated.

Pig Iron.

Business in pig iron has been on restricted lines throughout the past week, but a steady tone is maintained owing to fair inquiries on home account and some movement in the export department. Nothing has transpired so far, however, to indicate a probability of any addition being made to the small number of furnaces in blast.

Steel and Iron.

So far as the steel trade is concerned reports practically all refer to a tapering off in demands, instead of the usual call for supplies over the holidays. This has been particularly noticeable in steel plates and sections, due in a measure to the present poor demand from the shipyards. Buying in steel sheets has not been quite so brisk of late, but the majority of the mills are well sold over the first month or two of 1925. Demands for a long time now have been rather one-sided, and makers would welcome business on home account. Heavy sheets are improving slowly, while flat and corrugated galvanised varieties are especially firm at the moment. For some months now the bar ironworks have been poorly employed, and it is encouraging therefore to note a slight improvement on home account and brighter prospects in the export department. The same remarks apply to the re-rolled steel section of this industry. In accordance with the demand for other materials, business in scrap has been restricted, but at the same time some forward buying is reported at firm prices. Quotations for steel and iron remain unaltered.

Coal Markets Firm.

A stronger tone is noticeable in the coal market generally. An improved demand has been experienced for practically all descriptions of fuel, though all districts have not equally participated. The collieries in Lanarkshire are well sold to the end of the year at least for all fuels, with the exception of washed treble nuts, and immediate supplies can hardly be secured unless picked up through second-hands. Even the latter is not probable at present. A very firm tone is reported from the Lothians district, all prices having an upward tendency. The trade in Fifeshire has not improved to the same extent as in the other districts, partly owing to the fact that the colliery prices are outwith buyers' ideas and not to lack of demand. The home market is not so active as is usually the case at this season of the year, and supplies for domestic, municipal, or industrial purposes are readily obtained.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Retrospect.

IN the absence of any real news owing to the imminence of the holidays and in view of the fact that this is the last issue for the year, it will perhaps not be deemed out of place if I give a brief review of the coal industry for 1924. It is not a pleasant story; in fact, it forms a somewhat dismal chapter in the industrial history of this district. Looking back over the past twelve months it is difficult to find any section interested in the trade whether as workers at the mines or on the business side of the industry, which can derive any comfort from what has happened. It follows that thousands of people engaged in associated trades have felt the ill-effects of the depression in the coal trade, inasmuch as reduced output has meant restricted work for those engaged at the docks and on the railways. It has been an unsatisfactory year for the miners in particular, while the coalowners and the thousands of shareholders in the various colliery undertakings have suffered financially, in addition to which coal exporters and middlemen have undoubtedly experienced a very lean time. Shipowners have also been involved, as the percentage of those who have been able to make both ends meet must be a very small one. The curtailed demand from abroad for coals has resulted in a reduced inquiry for tonnage and, as a consequence, freights have ruled low and for the most part have been unremunerative, particularly for the small sized tonnage employed in the shorter trades.

The beginning of 1924 was fairly good; there was promise of really active conditions, but, unfortunately, the basis was not sound. The improvement in shipments can only be described as artificial. It will be recalled that the miners had given notice to terminate the wages agreements, and, as always happens in such circumstances, there was a disposition on the part of some foreign consumers, and especially the owners of foreign coaling stations, to lay in stocks for fear that trouble in the coalfield might result in cutting off supplies. But immediately this fear was removed by agreement being come to between the miners' leaders and the coalowners, there was a sharp falling off in the demand for coals. There was no reason to maintain heavy stocks of coal, with the result that the effect upon trade was very perceptible during the second quarter of the year and onwards. The new wages agreement meant an advance in the wages rate for this district from a minimum of 28 per cent. above the standard of 1915 to a minimum of 42.22 per cent. above the standard, and it was agreed that there should be a minimum wage of 8s. 0½d. per day to the lowest paid workman, with extra allowance for skilled men representing an advance of 6¾d. to 9¾d. per man per day to all not on piecework conditions. The new minimum of 42.22 per cent. above the standard has been in operation from the time that the agreement became operative, and it has been estimated that the working costs of collieries have been increased by 1s. 6d. to 2s. per ton. From June to October the loss on production was calculated to be at the rate of £1,770,000 per annum, and there is no reason to think that the conditions prevailing during the last two months of the year will have reduced this rate of loss. From the middle of the year onwards the position of the coalowners became increasingly serious, and almost every week news came to hand of notices being given to workmen to terminate their employment, as the losses in keeping pits working were becoming unbearable. Many pits have been closed permanently, while in the case of others work was resumed when sufficient orders could be secured to justify pits being reopened. In October it was officially stated that 40,000 miners were idle, representing approximately 17 per cent. of the total workmen employed in the industry in this district.

Not only had coalowners to face the abnormally heavy costs of production, which, of course, were increased by the irregularity of employment, but they had to meet very severe competition from foreign coalfields. German coals have been finding their way into the continental markets and even South America to the disadvantage of South Wales qualities which, of course, is not surprising in view of the fact that buyers could secure them at several shillings per ton below what sellers from this district could offer. While middlemen and firms holding coals on contract did not do so badly during the first half of the year, it is to be feared that their losses during the second half have been very heavy. During this period it was very difficult indeed for them to be able to find an outlet for their coals without incurring losses, and it is very well known that in some instances when business was most depressed sellers could not dispose of their contract coals without sacrificing anything from 2s. to 4s. per ton.

Naturally such disturbing conditions as these, with the outlook for the future none too promising, have had a detrimental influence upon the buying of supplies for delivery over 1925. There has been a certain amount of contracting, but the quantity of coals arranged for over the next twelve months is considerably below the average, and prices are approximately 1s. per ton below the contract prices for 1924. As regards market prices the following table of highest and lowest figures with comparative prices for 1923 will be of interest :—

	1923. Max.	1923. Min.	1924. Max.	1924. Min.
	s. d.	s.	s. d.	s.
Best large ..	50 0	27	32 6	27
Best smalls	33 6	17	23 0	15
Patent fuel ..	50 0	30	32 6	27

A near estimate of the total production of coal for South Wales for 1924 is 51,500,000 tons, which compares with 54,321,434 tons for 1923, whilst the average number of persons employed in the coalfield during the past twelve months was 240,000, as against 252,909 during 1923. The output per person for the year works out at about 215 tons, which is the same as last year. The one bright spot in the coal trade has been the anthracite section in which employment has been good and regular. The demand has been very satisfactory throughout the whole year, and prices have maintained a very good level.

The year has been a very trying one for shipowners, who have experienced great difficulty in finding profitable employment for their tonnage. The following are the highest and lowest rates of outward freights to a few of the principal ports, together with the average rates for the year 1914 :—

	1924. Max.	1924. Min.	Average for 1914.
	s. d	s. d.	s. d.
Algiers	11 9	7 7½	9 5
Barcelona	14 6	10 6	9 6
Buenos Aires	16 0	10 9	14 1
Genoa	13 6	7 6	8 7
Gibraltar	10 6	7 0	8 0
Port Said	13 9	9 3	9 11
Venice	15 0	10 6	10 10

It must be borne in mind when comparing the rates for the past year with the average of 1914 that the working costs of shipowners are now at least 75 per cent. higher than they were in 1914.

Current Business.

During the past few days business has been on a diminishing scale owing to the holiday conditions prevailing. Most shippers completed all their arrangements for loading immediately before and after Christmas and early last week, and since then they have been devoting their efforts to getting tonnage away. The tone of the market has consequently been quiet with comparatively little business passing, though prices have not undergone any alteration. The pitwood market has kept firm owing to the scarcity of prompt supplies and the improved demand as the result of stocking by the collieries.

Catalogues.

JAMES WILEY AND SONS, Limited, Darlaston.—Spanner list.

A. L. CURTIS, Westmoor Laboratory, Chatteris.—A catalogue of industrial sands.

GEORGE GREEN AND CO., Keighley.—Folder on Green's foundry equipment.

BRITISH STEAM SPECIALTIES, Limited, Fleet-street, Leicester.—Catalogue of pipe fittings.

E. C. BOWDEN-SMITH, 17, Victoria-street, S.W. 1.—Booklet and price list of Ismailia valves.

OZONAIR LIMITED, 96, Victoria-street, S.W. 1.—Pamphlet relating to the Ventex air filter.

STEAM FITTINGS COMPANY, Limited, West Drayton, Middlesex.—Brochure on oil separators.

FERRANTI LIMITED, Hollinwood, Lancashire.—List Tal 72, dealing with "Calcium Chloride Breathers."

BELLISS AND MORCOM, Limited, Ledsam-street Works, Birmingham.—Latest book on "Fuel Economy."

WILLIAM ASQUITH (1920), Limited, St. Hubert Works, Halifax.—Postcard illustrating the Asquith drill socket.

COOKE, TROUGHTON AND SIMMS, Limited, 5, Broadway, S.W. 1.—Booklet on Ozalid, a new paper for photo printing.

BELL'S UNITED ASBESTOS COMPANY, Limited, Southwark-street, S.E. 1.—Leaflet on the Viceroy cellular blocks.

TECALEMIT, Limited, 10, Little Portland-street, W. 1.—Lists F2 and L3 of the Tecalemit filter and lubricator.

JOSEPH FOSTER AND SONS, Soho Foundry, Preston.—Catalogue illustrating installations of Foster engines, boilers, &c.

WALWORTH-MUNZING, Limited, 90-96, Union-street, Southwark, S.E. 1.—Reference list of wrought iron tubes and fittings.

BRITISH ROPEWAY ENGINEERING COMPANY, Limited.—An illustrated ropeway catalogue.

NATIONAL BOILER AND GENERAL INSURANCE COMPANY, Limited.—Leaflet on the National patented circulator.

MANLOVE, ALLIOTT AND CO., Limited.—Leaflet illustrating the multi-jet washer, L type Decoudin, and a drying machine.

MCKECHNIE BROTHERS, Limited, Rotton Park-street, Birmingham.—An illustrative catalogue of the McKechnie products.

BUCKLEY, SAUNDERS and Co., Limited, 8, Princes-street, S.W. 1.—Publication No. 252, describing the Pontelec electric rivet heater.

FERODO LIMITED, Sovereign Mills, Chapel-en-le-Frith.—Publication No. 550 on Ferodo friction linings for colliery and mine machinery.

THE MIRRLEES WATSON COMPANY, Limited, Scotland-street, Glasgow.—Catalogue P.U. 950, dealing with "Mirrlees" steam ejector air pumps.

RONALD TRIST AND CO., Limited, 12, Clipstone-street, W. 1.—Album S. 19, in five languages, on S.E.A. ring packings as applied to various machines.

STANTON IRONWORKS COMPANY, Limited, near Nottingham.—The latest publication concerning Stanton centrifugally concrete lined iron pipes.

R. WHITE AND SONS, Widnes, Lancashire.—Booklet catalogue in connection with Messrs. White's specialties in railway work and aerial wire ropeways.

HOLLINGS AND GUEST, Limited, Thimble Mill-lane, Birmingham.—Illustrated list No. A106, illustrating and describing the standard scrap metal bundling press.

MATHER AND PLATT, Limited, Park Works, Manchester.—Catalogue No. T 185, illustrating the firm's machinery for bleaching, dyeing, printing and finishing.

UNDERFEED STOKER COMPANY, Limited, Aldwych House, Aldwych, W.C. 2.—Catalogue of installations of stokers, air heaters, coal and ash conveying plant, &c.

JAMES ARCHDALE AND CO., Limited, Ledsam-street, Birmingham.—Catalogue illustrating and describing the firm's latest types of drilling machines and milling machines.

HOLMAN BROTHERS, Limited, Camborne, Cornwall.—A very elaborate Wembley souvenir, consisting of over 100 pages relative to the manufactures of Messrs. Holman.

A. ROSS, HOTCHKISS AND CO., Limited, 1, Glengall-road, Old Kent-road, S.E.—"Notes on the Transfer of Heat to Water and Some of the Engineering Problems Involved."

BRUSH ELECTRICAL ENGINEERING COMPANY, Limited.—Publication 1004, giving a reprint from the *Power Engineer* entitled "Brush-Ljungström Plant in a Cement Works."

CROMPTON AND CO., Limited, Chelmsford, England.—Leaflets No. 240 and 245 on house lighting and semi-automatic ironclad switchboards; List C. 12a of direct-current generators.

FULLER'S UNITED ELECTRIC WORKS, Limited, Woodland Works, Chadwell Heath.—List No. 326 of the Sparta headphone and List No. 230 of the Sparta one-valve amplifier.

STERNS, Limited, Royal London House, Finsbury-square, E.C. 2.—Two publications: "The Lubrication of Steam Turbines" and "Lubrication of Diesel and other Types of Heavy Oil Engines."

RANSOME MACHINERY COMPANY (1920), Limited, 14–16, Grosvenor-gardens, S.W. 1.—Leaflet No. 2 on the Ransome steel wheel barrow, and leaflet No. 3 on steel buildings and colliery plant.

ENGLISH ELECTRIC COMPANY, Limited, Queen's House, Kingsway, W.C. 2.—Publication No. 306, which illustrates and describes "English Electric" transformers up to 1000 kilovolt-ampères.

ENGINEERING AND LIGHTING EQUIPMENT COMPANY, Limited, Sphere Works, St. Albans, Herts.—Catalogue No. 7, giving particulars of the extensive range of industrial lighting fittings manufactured by the firm.

THE BRITISH THOMSON-HOUSTON COMPANY, Limited, Rugby.—Descriptive list No. 2141 of induction motors (small sizes), and price list No. 5351 A of direct-current motor control pillars, (industrial type C.D.P.).

A. J. STEVENS AND CO. (1914), Limited, Walsall-street Branch, Wolverhampton.—Booklet on wireless telegraphy instructions and information, which is now in its second edition and published at 6d. a copy.

SIR ISAAC PITMAN AND SONS, Limited, Parker-street, Kingsway, W.C. 2.—A book entitled "Pitman's Technical Bookshelf," No. 7, giving extracts from various new and forthcoming technical books published by the firm.

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY East Pittsburgh, Pa, U.S.A.—A booklet on fine material for mines; and leaflets L 1624–B and L 1719, on starting panels for synchronous motors and single operator arc welding equipment.

DOBBIE, MCINNES AND CLYDE, Limited, 50, Bothwell-street, Glasgow.—Catalogue Ref. 12 of the "Hopkinson Optical Indicator." No. 11 of the Dobbie-McInnes indicators and other specialities, and Catalogue Ref. 10 of the "Farnboro" electric indicator.

GEORGE SWIFT AND SONS, Limited, Claremont Ironworks, Halifax, England.—List E, illustrated specification and description of "Swift" high-speed radial drilling, tapping and studding machines; and List L, illustrated specification and description of "Swift" all-geared head lathes.

DELCO-REMY AND HYATT, Limited, 56, Victoria-street, S.W. 1.—A loose leaf catalogue with sheets I.N. 1 to 45 and the four latest pages I.N. 46 to 52, which deal with light truck and trolley wheels, crane wheels, winches, tramcar axle-boxes, and electric traction motors fitted with Hyatt bearings.

CONTRACTS.

THE CHILE EXPLORATION COMPANY, of New York, has accepted the tender of Thos. W. Ward, Limited, of Sheffield and Silvertown, for the supply of 20,000ft. of 8in. diameter steel screwed and socketed piping for shipment to Antofagasta. This order was secured against keen competition from the United States.

IN connection with the power station extensions contract recently placed by the Poplar Borough Council with Vickers and International Combustion Engineering, Limited, as main contractors, we learn that the condensing plant for the 10,000-kilowatt turbo-alternator is to be of the Contraflo high-vacuum design supplied by Vickers Limited, Barrow-in-Furness.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	17/6 to 24/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 15 0	—
No. 1 Foundry	4 15 0	—
No. 3 Foundry	4 10 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 8 6	4 8 6
No. 1	4 9 0	4 9 0
Cleveland—		
No. 1	4 6 6	4 6 6
Silicious Iron	4 6 6	4 6 6
No. 3 G.M.B.	4 1 6	4 1 6
No. 4 Foundry	4 0 6	4 0 6
No. 4 Forge	4 0 0	4 0 0
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
„ „ Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 16 0 to 3 17 0	
„ Forge	3 11 0	—
(3) Derbyshire—		
No. 3 Foundry	4 2 6	—
Forge	3 16 6 to 3 17 6	
(3) Lincolnshire—		
No. 3 Foundry	4 2 6	—
No. 4 Forge	4 0 0	—
Basic	4 5 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	5 2 6 (a)	—
	5 7 6 (b)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 0 0	—
Best „	—	—
N.E Coast—		
Common Bars	12 0 0	—
Lancs —		
Crown Bars	13 0 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	13 0 0	—
Best „	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	13 15 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 15 0	—
Gas Tube Strip	13 5 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	13 0 0	—
Ship Plates, ½in. and up	9 15 0	—
Sections	9 10 0	—
Steel Sheets, 5/16in. to ½in.	12 0 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	9 15 0	—
Angles	9 10 0	—
Boiler Plates	13 0 0	—
Joists	9 10 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	9 10 0	—
Soft Billets	8 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 0 0†	—
Light „	9 5 0 to 9 10 0	
Billets	8 0 0 to 11 10 0†	
Manchester—		
Bars (Round)	10 0 0 to 10 10 0	
„ (others)	9 15 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	9 15 0 to 10 0 0	
„ (Lancs. Boiler)	13 0 0	—
Sheffield—		
Siemens Acid Billets	11 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	9 10 0	
Intermediate Basic	9 0 0	
Soft Basic	8 0 0 to 8 5 0	
Hoops	12 0 0	—
Soft Wire Rods	11 0 0 to 11 10 0	
Midlands—		
Small Rolled Bars	9 5 0 to 10 0 0	
Billets and Sheet-bars	7 10 0 to 7 15 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 7 6 to 17 10 0	
Angles	9 5 0	—
Joists	9 5 0	—
Tees	10 5 0	—
Bridge and Tank Plates	9 15 0	—
Boiler Plates	13 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	23/6 to 23/7½
Block Tin (cash)	261 5 0
„ (three months)	264 10 0
Copper (cash)	85 12 6
„ (three months)	86 12 6
Spanish Lead (cash)	42 10 0
„ (three months)	39 12 6
Spelter (cash)	37 12 6
„ (three months)	37 3 9
Manchester—	
Copper, Best Selected Ingots	70 10 0
„ Electrolytic	71 10 0
„ Strong Sheets	96 0 0
„ Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 1 0½
„ Condenser	0 1 2½
Lead, English	45 0 0
„ Foreign	43 15 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/8½ per lb.	
Ferro Tungsten	1/4½d. per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	8/-
„ 6 p.c. to 8 p.c. „	£23 10 0	7/9
„ 8 p.c. to 10 p.c. „	£23 0 0	7/8
„ Specially Refined		
„ Max. 2 p.c. carbon	£43 0 0	16/-
„ „ 1 p.c. „	£52 0 0	17/6
„ „ 0.75 p.c. carbon	£60 0 0	20/-
„ „ carbon free	1/5 per lb.	
Metallic Chromium	4/2 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 15 0	scale 5/- per unit
„ „ 75 p.c.	£17 17 6	scale 6/- per unit
„ Vanadium	17/6 per lb.	
„ Molybdenum	7/9 per lb.	
„ Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£165	
Cobalt	10/- per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	16/9
„ „ Ell	18/9
„ „ Splint	22/6 to 23/
„ „ Trebles	19/3
„ „ Doubles	18/6
„ „ Singles	15/-
Ayrshire—	
(f.o.b. Ports)—Steam	16/9
„ „ Splint	22/6
„ „ Trebles	19/3
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	15/1½ to 18/
Screened Navigation	24/6
Trebles	21/-
Doubles	19/-
Singles	15/6
Lothians—	
(f.o.b. Leith)—Best Steam	18/3
Secondary Steam	17/3
Trebles	20/-
Doubles	19/-
Singles	14/-

ENGLAND.

(8) N.W. Coast—	
Steams	28/6
Household	45/- to 58/4
Coke	30/-
Northumberland—	
Best Steams	18/6 to 18/9
Second Steams	17/6 to 18/-
Steam Smalls	10/6 to 10/9
Unscreened	15/6 to 17/-
Household	23/6 to 25/-
Durham—	
Best Gas	21/6
Second	18/3 to 18/6
Household	23/6 to 25/-
Foundry Coke	23/- to 24/6
Sheffield—	Inland.
Best Hand-picked Branch	32/- to 35/- —
Barnsley Best Silkstone	26/- to 28/- —
Derbyshire Best Brights	27/- to 32/- —
„ „ House	24/- to 26/- —
„ „ Large Nuts	22/6 to 25/- —
„ „ Small	14/- to 18/- —
Yorkshire Hards	20/- to 22/6 —
Derbyshire „	19/6 to 22/- —
Rough Slacks	9/6 to 12/- —
Nutty „	8/6 to 10/6 —
Smalls	4/- to 6/6 —
Blast-furnace Coke (Inland)*	— —
„ „ (Export)	f.o.b. 21/6 to 22/6

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	27/6 to 28/-
Second „ „	26/- to 27/-
Best Dry Large	27/- to 27/6
Ordinary Dry Large	24/- to 26/-
Best Black Vein Large	24/6 to 25/-
Western Valley „	23/6 to 24/6
Best Eastern Valley Large	23/6 to 24/6
Ordinary „ „	22/6 to 23/-
Best Steam Smalls	16/- to 18/-
Ordinary „	13/- to 15/-
Washed Nuts	22/- to 32/-
No. 3 Rhondda Large	27/- to 27/6
„ „ Smalls	19/- to 20/-
No. 2 „ Large	22/6 to 23/6
„ „ Through	18/- to 20/-
„ „ Smalls	11/- to 13/-
Foundry Coke (export)	40/- to 47/6
Furnace Coke (export)	27/6 to 32/6
Patent Fuel	25/6 to 27/-
Pitwood (ex ship)	32/- to 32/6
Swansea—	
Anthracite Coals	
Best Big Vein Large	47/6 to 50/-
Seconds	37/6 to 40/-
Red Vein	32/6 to 35/-
Machine-made Cobbles	50/- to 55/-
Nuts	55/- to 60/-
Beans	44/- to 45/-
Peas	19/- to 23/-
Breaker Duff	9/3 to 9/9
Rubbly Culm	11/6 to 12/-
Steam Coals:	
Large	22/6 to 23/6
Seconds	22/- to 22/6
Smalls	14/- to 16/-
Cargo Through	17/- to 19/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast furnaces only, 16/9, with fluctuations according to analysis; open market, round about 22/6 to 25/- at ovens. † Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Aviation.

THE annual show of aeroplanes which has just been held in Paris accentutated the tendencies that have been observable for some time past in the industry, but in no case could there be said to be a distinct departure, either in design or in constructional methods. The huge machines exhibited in previous years have been replaced by others of more modest proportions to carry from four to five passengers and fitted with more powerful engines. It is found preferable to increase speeds and fly at higher altitudes than to augment the number of passengers carried, and there is a general tendency in commercial machines to limit the total load to about a ton and to secure greater acceleration, while the possibility of flying higher renders machines less liable to weather disturbance than in the lower atmosphere. There were more monoplane machines than in former years, but there was no falling off in the number of biplanes exhibited, this type being evidently destined to maintain its supremacy for the heavier loads. All-metal construction showed marked progress, although French firms have been less prompt to adopt this system than makers abroad, but the difficulties in the way of assembling the light metal parts having been overcome it is probable that metal will be employed much more extensively in the future. In most cases metal was employed in conjunction with wood in the construction of the machines. Improvements in engine construction consisted almost entirely in a reduction of weight due to a rigid selection of high resistance metals. Progress in aero-engines appears to have come almost to a standstill. The results obtained are certainly remarkable, but the demands made upon the aero-engine are exceptionally severe, and trials carried out recently showed that very few came through the test satisfactorily. Some interest is now being centred in the turbine engine, of which two different systems have undergone tests, one of them being alleged to have run at a speed of 20,000 revolutions per minute for 200 hours.

An Original Engine.

At a meeting of the Société de Navigation Aérienne, M. Clerget presented a communication upon some experiments that were carried out by the brothers Niépce in 1806 with what appears to have been the precursor of the internal combustion engine. The brothers Niépce are more particularly known for their work in connection with the science of photography, and the results they achieved with the first internal combustion engine were soon forgotten, although they were recorded in a communication made to the Institute of France by Lazare Carnot at the end of 1806. The description of the engine is too vague to allow of any idea being formed of its general arrangement. It is referred to as a cylindrical receptacle with pistons. It was, in any case, fitted to a small boat which ascended the river Saône against the current. The engine was known as the Pyréolophore, and, according to M. Clergot, experiments were made with various kinds of fuel, including pulverised coal and petroleum oils, but they had to be abandoned through lack of funds. Claude Niépce went to England with his invention in the hope of finding capital, and, failing to do so, died there in poverty.

Railway Rates.

The Conseil Supérieur des Chemins de Fer has authorised the railway companies to increase the rates on goods by 7.4 per cent. At the time the Conseil Supérieur was constituted it was hoped to realise economies in the organisation of the railway companies whereby it would be possible to dispense with the State guarantees. The railways were to be self-supporting and some of the deficit in railway working was wiped out by a notable increase in passenger fares. Rates for the carriage of goods were advanced to a less extent, but they nevertheless created a good deal of dissatisfaction as making a further addition to the increasingly heavy charges upon manufacturers. Each attempt to increase the rates has been strongly opposed, but the Conseil Supérieur finds now that it has no alternative but to put up the rates in the hope that the additional revenue will allow the railway companies to pay their way.

Wagons.

Some orders for wagons have been distributed just when builders were beginning to fear that they would have to discharge practically the whole of their hands. In one case 2500 men were on the point of being paid off when an order for wagons was received from the Est Railway. Competition for the work is so keen that it has to be taken at exceptionally low prices, and in most cases builders are glad to accept orders providing little or no profit for the sake of keeping the works going. They have rarely experienced such trying times as during the past five years, when they have been employed almost exclusively upon the precarious task of repairing rolling stock. Even that work ceased entirely some months ago. Complaints are so general of a dearth of wagons that builders are hoping to receive further orders, despite the intention of the Government to obtain rolling stock from Germany on account of reparations.

Carbonising Plants.

In view of the probable heavy demand for charcoal for suction gas plants for motor vehicles, if only the fuel can be produced at a low enough cost, the Minister of Agriculture and the Minister of Commerce and Industry have organised a trial of portable carbonising plants which is to take place in the Forest of Senart in June next. Three prizes will be awarded for apparatus capable of being employed in the forests and of producing charcoal at a reasonably low cost. Those competitors who do not receive prizes will be paid 100f. per ton of charcoal produced, on condition of its being of sufficiently good quality to be utilised. Entries should be made to the Ministère de l'Agriculture (Direction Générale des Eaux et Forêts, 2e, Bureau), 78, Rue de Varenne, Paris, before March 1st next.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

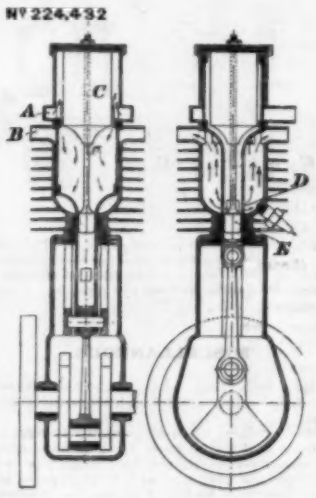
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

224,432. February 20th, 1924.—TWO-STROKE ENGINES, A. Romanelli, 31, Corso Cavour, Maurata, Italy.

In this engine the cylinder is reversed, that is to say, the combustion chamber faces the crank shaft. The inlet ports are at

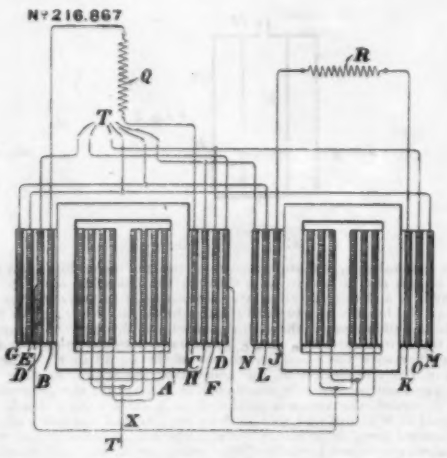


A and the exhaust at B. The charge is compressed inside the hollow piston, against the fixed filling piece C, and is transferred to the combustion space through the hollow piston-rod when the ports D overrun the fixed piston E.—*November 13th*, 1924.

TRANSFORMERS AND CONVERTERS.

216,867. May 23rd, 1924.—IMPROVEMENTS IN AND RELATING TO ALTERNATING-CURRENT TRANSFORMERS, *The British Thomson-Houston Company, of Crown House, Aldwych, W.C.* 2.

The general object of this invention is to provide an improved arrangement and interconnection of transformer windings for converting polyphase current from a two-phase source into six-phase current, suitable for various purposes, such as the operation of synchronous converters and alternating-current rectifiers. One advantage of the scheme is that the internal power factor of the transformer system is unity. Moreover, all the interconnections between the transformer windings are on the six-phase side, where the problem of providing the necessary insulation is simplest. Other advantages are also claimed. In the case of the arrangement shown, two single-phase transformers are employed, each being of the core type with two

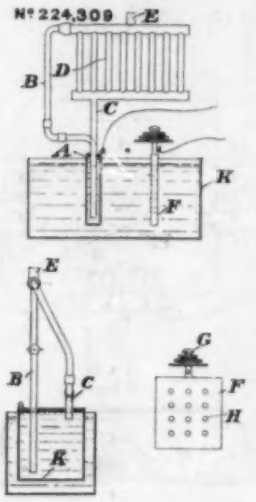


winding legs. One of the transformers includes a core A, a primary winding B C, and three secondary windings, D D, E F, G and H, each winding being divided into two equal series-connected sections. The other transformer includes a primary winding J K and two secondary windings L M and N and O, each of these windings being also divided into two equal sections. Voltages, having a relative phase displacement of 90 deg., are impressed respectively on the two primary windings B and C and J and K by connecting these windings to the phases Q and R of any suitable source of two-phase current. Six-phase current is delivered at the terminals T, the neutral terminal being shown at X. Diagrams showing the internal connections are given.—*November 13th*, 1924.

ELECTRICAL APPLIANCES.

224,309. August 15th, 1923.—IMPROVEMENTS IN AND CONNECTED WITH ELECTROLYTIC RECTIFIERS FOR ALTERNATING CURRENT, Raoul Felice Bossini, of 167, Uxbridge-road, Shepherd's Bush, London, W. 12.

The rectifier described in this specification is claimed to overcome the defects of apparatus of this class. The anode A is in the form of a hollow rectangular receptacle, which is sealed at the top. Two lead pipes B and C are connected to the upper and lower parts of a tubular radiator D. The radiator and receptacle A can be filled with water or oil at the port E. The cathode, which is shown at F, is cast in one piece with a circular radiator G, and to assist the circulation round the cathode F it is perforated with holes H. The operation of the apparatus is as follows:—The vessel K is filled with the electrolyte, and the radiator D and the anode A are filled with water or oil by the opening E. As soon as the current passes the electrolyte begins

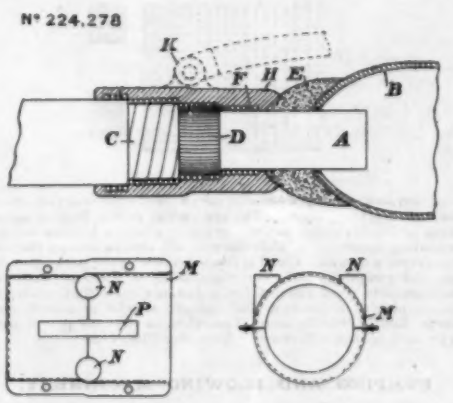


to heat, and this heat is collected on the cathode F and on the surface of the anode A. Being made of aluminium and a good conductor of heat, the circular radiator G disperses the heat collected by the cathode F, and in the anode A. The water or oil collects the heat of the container K, and this liquid will rise in the pipe C, causing circulation of the liquid in the radiator D, which, by the pipe C, delivers to the anode A the liquid which has been cooled in the radiator D. The cathode F and the anode A thus keep the electrolyte cooler, and enable a large quantity of current to pass.—*November 15th*, 1924.

TRANSMISSION OF POWER.

224,278. August 3rd, 1923.—IMPROVEMENTS IN AND CONNECTED WITH ELECTRIC CABLES, British Insulated and Helsby Cables, Limited, and John Lewis Parker, both of Prescot, and Charles Vernier, of 59, Church-road, Gosforth, Northumberland.

The chief objects of this invention are to protect and reinforce against internal pressure the portions of the sheath of the cable ends which are secured to the box in which the ends of the cable are introduced, and to provide a suitable means of holding the end of the armouring. In this drawing, A represents the lead sheathing of the cable, and B is the box. C is a metal tape or strip armouring which may be spirally wound round the cable. D is the internal helical wire armouring, and E is a wiped or plumber's joint connecting the end of the box with the sheath A. The helical armour wires D are removed from the lead sheathing to a point some distance away from the end of the wiped joint E, and in the case shown the helical metal tape windings C are removed for a greater distance from the joint than the wires D. Round the completely bared part of the sheath A between the end of the wiped joint E and armouring D, copper or other wires F are wound. In the case shown, these windings are extended over the bared portion of the armouring wires D, and the metal armouring tape winding C. The whole of these portions of the cable, including a portion of the wiped joint E, is enclosed and



covered by a sleeve H of lead or lead alloy, having a low melting point, this sleeve being cast round the parts. By removing the armouring wires from the lead sheathing in the manner described, viz., to a point some distance from the commencement of the wiped metal E, interference with the operation of making the wiped joint with the sheath A is avoided. In making this connection or applying the sleeve and reinforcement, the cable armouring is first cleansed and secured in position by a metal binding. In the case shown, this is done by tinned copper wire, it being tinned in order to enable it to adhere to the lead or other metal reinforcement H, which is applied over it; whilst the portion of the wire F between the ends of the armouring and the wiped joint E protects the lead cable sheath from injurious heating and possible melting during the application of the metal of low melting point forming the sleeve H, in addition to providing additional reinforcement to it. These metal bindings are suitably secured, as, for example, by twisting together the ends and soldering. The sleeve H may have a lug K attached to it, to serve as an electrical bonding means. The usual clamps for making electrical connection between the armouring at each side of the joint, and the joint box or case, are therefore rendered unnecessary. The mould M may be composed of sheet metal, made in halves with flanges, clamped together, and applied over the portion of the cable to which the lead or other metal

sleeve is to be cast, the metal being fed into it through the filling spouts N, a vent hole P being provided to allow of the escape of air and gases.—*November 3rd*, 1924.

224,430. February 18th, 1924.—AN IMPROVED METHOD AND MEANS FOR BONDING METAL-SHEATHED ELECTRIC WIRES AND CABLES, Charles William Bloomfield, of 190, London-road, Hackbridge.

This specification describes a new method of bonding metal-sheathed electric wires and cables, which is particularly applicable to junction boxes, ceiling roses and similar devices employed

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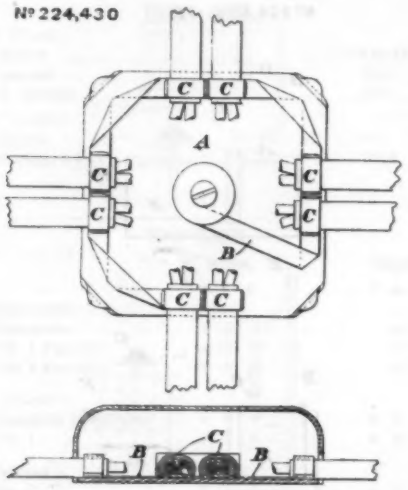

in electric wiring installations for the purpose of earthing the outer metallic sheathing of the wires or cables. In the drawing, the metal base plate of a junction box is shown at A, and it is connected to a narrow strip or band of relatively thin ductile metal B. The strip is held in contact with the metallic covering of the leads by spring clips C. Preferably the clips are made of thin spring steel or phosphor bronze.—*November 13th*, 1924.

MEASURING AND TESTING INSTRUMENTS.

224,475. August 17th, 1923.—PENS FOR RECORDING INSTRUMENTS, The Seaton Delaval Coal Company, Limited, Seaton Delaval, Northumberland; J. S. Tweddell, East View, Seaton Delaval; A. Stoker, Delaval House, Seaton Delaval; J. D. Shaw, 3, St. Michael's-avenue, New Hartley; J. Howarth, 6, St. Michael's-avenue, New Hartley; S. J. Gerrett, 14, Bristol-street, New Hartley; and T. Hall, 9, Bristol-street, New Hartley.

This invention relates to recording apparatus and more especially to the kind in which the pen is driven by means of a

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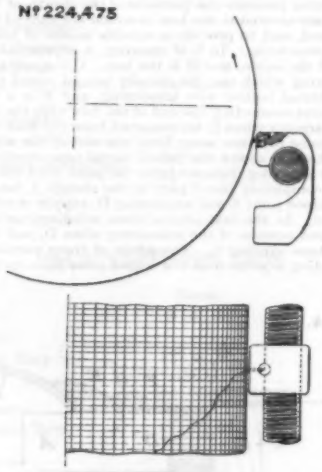


threaded shaft arranged parallel to the face of the chart on which the record is to be made. The pen carrier in this form of apparatus preferably comprises a portion of a nut, a balance weight extending therefrom so that the nut will always occupy the one transverse position. A well is formed in the upper portion of the nut and a capillary tube communicating at one end with the well, projects from the nut for a distance such that when the nut is placed in position the balance weight is moved outwards slightly from its normal position, so that the pen or tube is pressed against the chart.—*November 13th*, 1924.

PUMPING AND BLOWING MACHINERY.

224,758. January 14th, 1924.—AIR COMPRESSORS, R. Bernat, 5 to 15, Rue de Moscou, Bordeaux, France.

This high-speed compressor is intended for high pressures and has a rotary inlet valve A, while the delivery valves B are of the automatic type. The inlet valve is driven at a speed less than that of the crank shaft and has a correspondingly increased number of ports. The delivery valves, as will be seen in the detail drawing, comprise balls seated in conical holes, with a

Nº 224,758

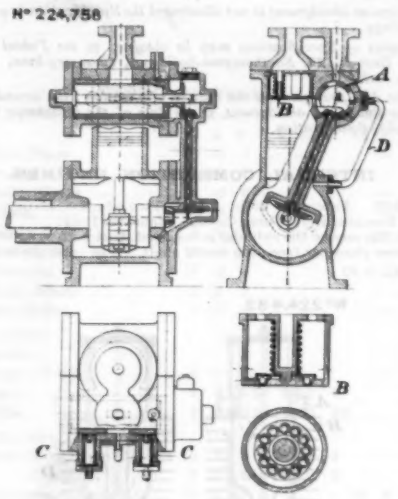


plate and spring above to keep them in place. The plungers C C, which are subject to the air pressure, are used to press the inlet valve against its port face. Lubrication is effected down the hollow valve gear spindle and by the pipe D.—*November 20th*, 1924.

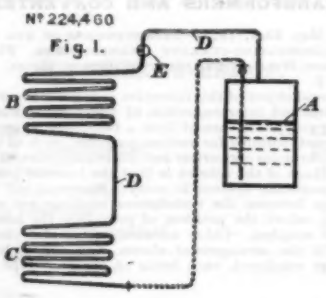
MISCELLANEOUS.

224,460. April 25th, 1924.—AN ABSORPTION REFRIGERATING MACHINE, E. Rumpler, 100, Friedrichstrasse, Berlin, N.W. 7, Germany.

This invention relates to an absorption refrigerating machine for intermittent working, in which the generator, condenser and evaporator are connected together by a single pipe, which serves both as an expulsion pipe and as a re-absorption pipe for the refrigerating medium. As Fig. 1 shows, the generator A, condenser B and refrigerator C are connected by a single pipe D, which serves both for expelling and also for re-absorbing the cooling medium (ammonia). A three-way cock E, which is used for admitting cooling medium, is provided in the pipe D. The operation is as follows:—The gas, which is generated, collects in the upper part of the reservoir or main portion of

Nº 224,460

Fig. 1.



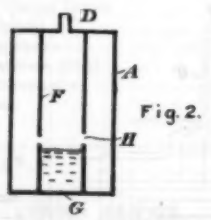


Fig. 2.

the generator A, and the pressure of the gas upon the liquid in A causes that liquid to pass through the holes H—see Fig. 2, which is a detail sketch of the generator—into the cylinder F until the level of the liquid in A lies below the row of holes H. The gas then escapes through the holes and through the column of liquid in F into the pipe D, and thence into the condenser B, together with the gases driven out of the liquid in F. When, upon the completion of the generating operation, heating is stopped and in order to commence re-absorption the generator A is cooled, the vacuum produced in A causes the column of liquid in F to fall and that in A to rise, so that the gases to be absorbed are able to return through the row of holes H into the reservoir or main portion of the generator A, and are thereby absorbed by reason of their fine state of division.—*November 13th*, 1924.

END OF VOL. CXXXVIII.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

1925.

FRIDAY, JANUARY 2ND.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "Modern Flour-milling Machinery," by Mr. W. Ringrose. 7.30 p.m.

TUESDAY, JANUARY 6TH.

INSTITUTE OF MARINE ENGINEERS.—85-88, The Minories, Tower-hill, London, E. 1. "Some Considerations in Connection with the Measurement of Liquid Fuel Storage and Liquid Depths," by Mr. C. H. Wright. 6.30 p.m.

WEDNESDAY, JANUARY 7TH.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Water Gauge," by Mr. Oswald Stott. 7 p.m.

FRIDAY, JANUARY 9TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. Informal meeting. "The Maintenance of High-compression Oil Engines." 7 p.m.

MONDAY, JANUARY 12TH.

INSTITUTE OF TRANSPORT: YORKSHIRE LOCAL SECTION.—Town Hall, Leeds. Inaugural address by the Chairman, Mr. J. B. Hamilton. 5.30 p.m.

LAUNCHES AND TRIAL TRIPS.

G. W. HUMPHREYS, sludge vessel; built by Vickers Limited to the order of the London County Council; dimensions, 260ft. by 43ft. 6in. by 16ft. 10in.; to carry 1500 tons. Engines, three-crank, inverted vertical, direct-acting, triple-expansion, 16in., 26in., 42in. by 27in. stroke, pressure 180 lb.; constructed by the builders; launch, November 13th.

SKEGNESS, steamer; built by Workman, Clark and Co., Limited, to the order of Sir Wm. Reardon Smith and Sons, Limited; dimensions, 415ft. long; 4600 gross tonnage. Engines, single screw, vertical inverted, direct-acting, surface condensing, triple-expansion; constructed by the builders; launch, November 13th.

H.P. AND H.C. No. 6, hopper barge; built by Irvine's Shipbuilding and Dry Docks Company, Limited, to the order of the Hartlepool Port and Harbour Commissioners; dimensions, 132ft. by 28ft. by 12ft.; 490 tons deadweight. Engines, twin-screw compound, 12in. and 27in. by 20in. stroke; constructed by W. Sisson and Co., Limited, Gloucester; trial trip, November 19th.

GRIPSHOLM, twin-screw passenger motor ship; built by Sir W. G. Armstrong, Whitworth and Co., Limited, to the order of the Swedish American Line; dimensions, 574ft. 6in. by 74ft. 3in. by 76ft. 6in.; 17,000 gross tonnage. Engines, two four-cycle double-acting reversible; constructed by the builders; launch, November 26th.

SINGLE-SCREW TUG; built by J. I. Thornycroft and Co., Limited, to the order of the High Commissioner of South Africa; dimensions, 100ft. by 24ft. by 13ft. 6in. Engines, triple-expansion, surface-condensing, direct-acting, 13½in., 22in., 35in. by 27in. stroke; constructed by the builders; completed, November 26th.

SAMTHIA, passenger and cargo steamer; built by Swan, Hunter and Wigham Richardson, Limited, to the order of the British India Steam Navigation Company, Limited; dimensions, 451ft. by 57ft. 9in. by 30ft. 6in.; 9500 tons deadweight. Engines, triple-expansion; constructed by the builders; launch, November 27th.

USKMOOR, steel screw collier; built by the Blyth Shipbuilding and Dry Docks Company, Limited, to the order of the Moor Line, Limited; dimensions, 330ft. 8in. by 42ft. 11in. by 26ft. 9in.; to carry 4050 tons. Engines, triple-expansion, 23½in., 38in., 64in. by 42in. stroke; constructed by the North-Eastern Marine Engineering Company, Limited; trial trip, November 27th.

RYDAL HALL, single-screw steamer; built by Barclay, Curle and Co., Limited, to the order of Ellerman Lines, Limited; dimensions, 416ft. by 54ft. 9in. by 32ft.; 7000 gross tonnage. Engines, triple-expansion, 23½in., 40½in., 71in. by 48in. stroke; constructed by the builders; launch, November 28th.

COMLIE BANK, twin-screw motor vessel; built by Harland and Wolff, Limited, to the order of the Bank Line, Limited; dimensions, 434ft. by 53ft. 9in. by 37ft.; 5200 gross tonnage. Engines, two sets of six-cylinder Diesel; constructed by the builders; trial trip, December 6th.

LUBRAFOL, twin-screw Diesel tanker; built by Sir W. G. Armstrong, Whitworth and Co., Limited; to the order of Société Anonyme d'Armement d'Industrie; 10,100 tons deadweight. Engines, Armstrong-Sulzer two-stroke type; constructed by the builders; trial trip, December 6th.

RUDBY, steamer; built by Wm. Gray and Co., Limited, to the order of Sir R. Ropner and Co., Limited; dimensions, 402ft. by 55ft. by 28ft. 9in. Engines, triple-expansion, 26in., 43in., 71in. diameter by 48in. stroke, pressure 180 lb.; constructed by the builders; trial trip, December 6th.

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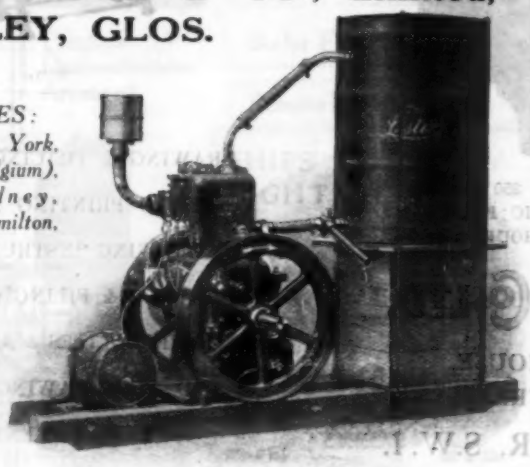

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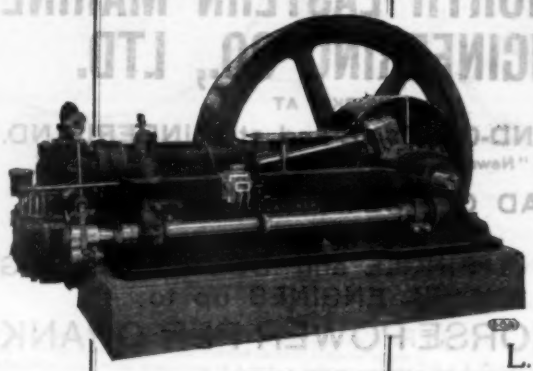

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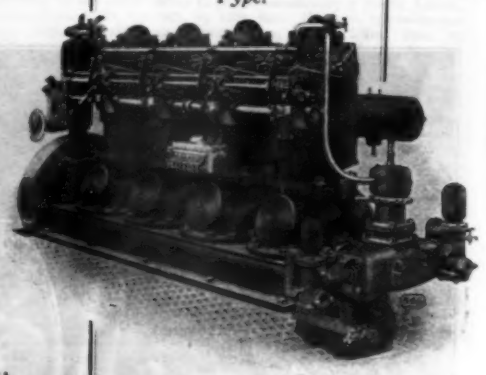

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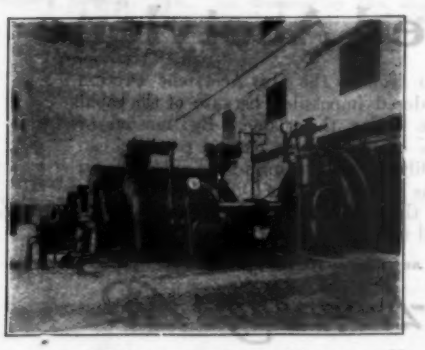

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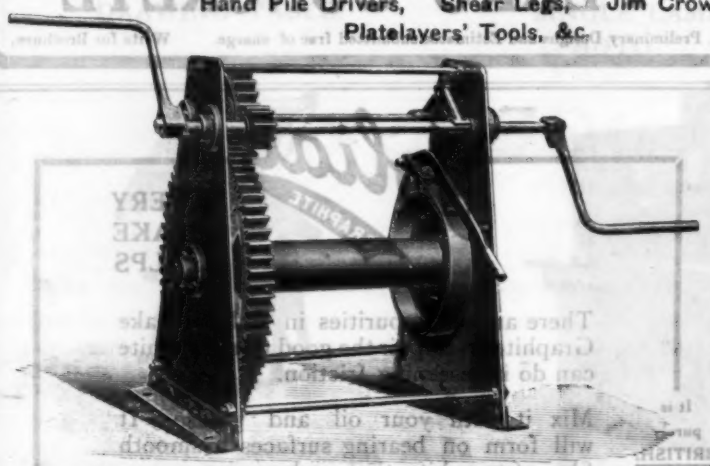

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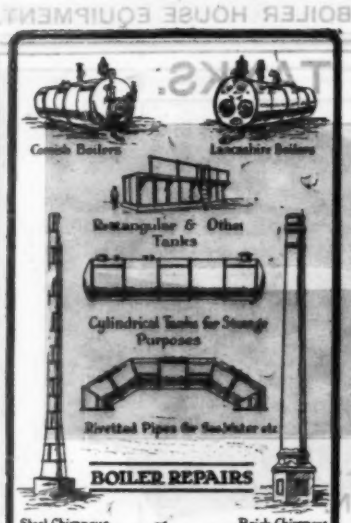

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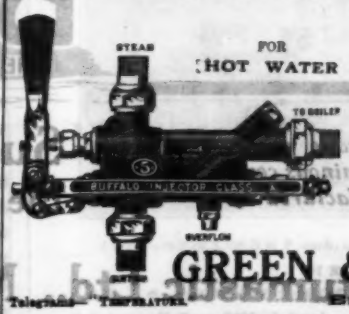

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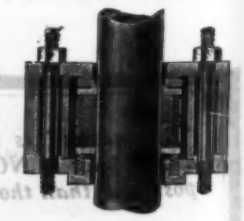

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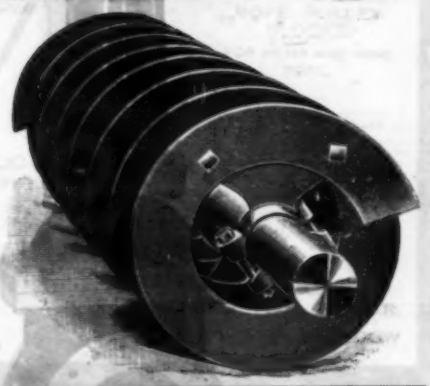

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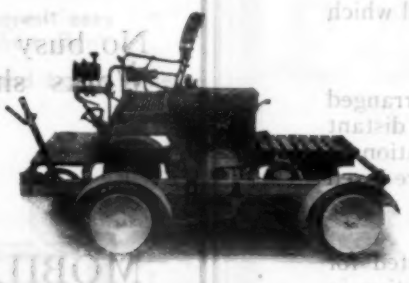

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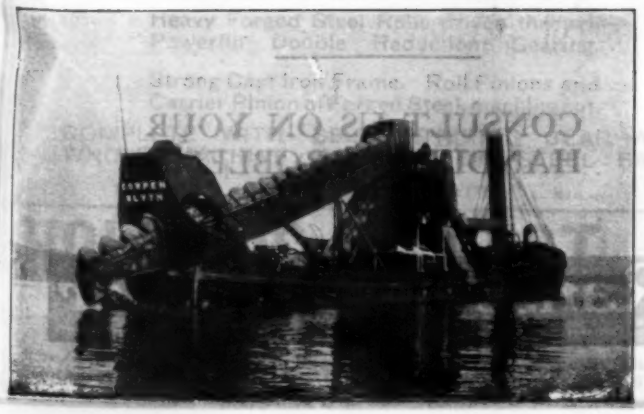

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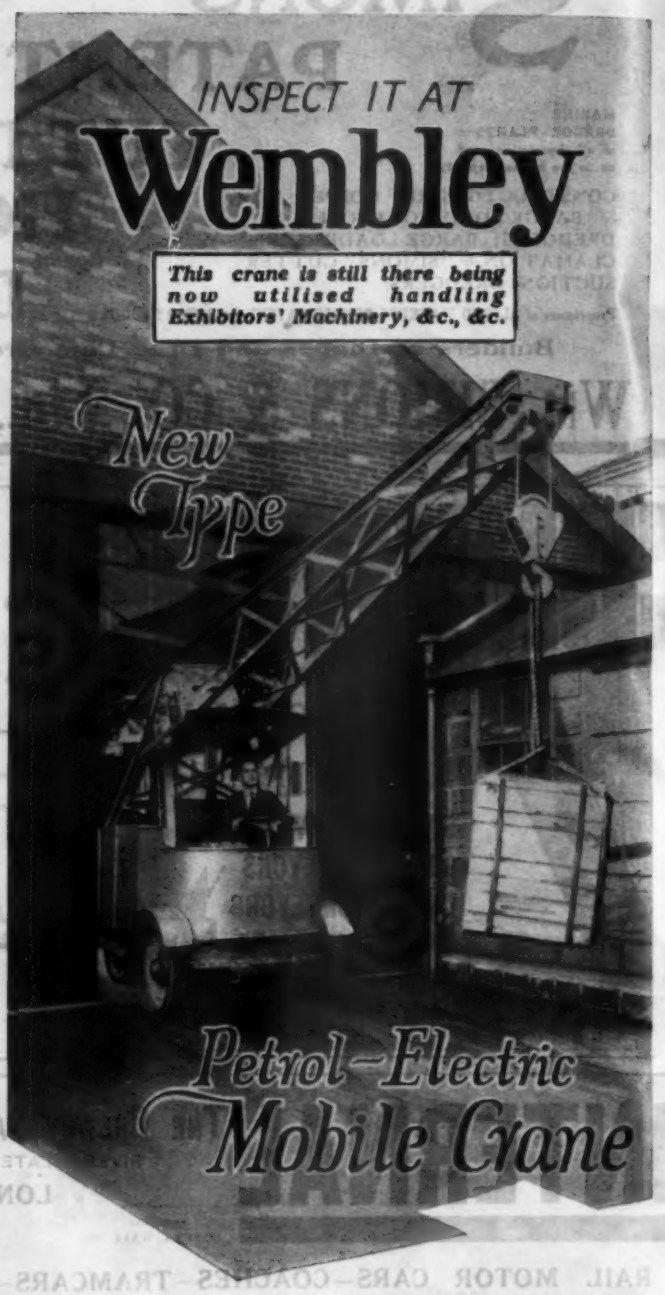

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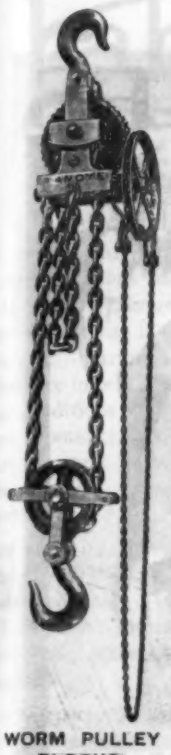

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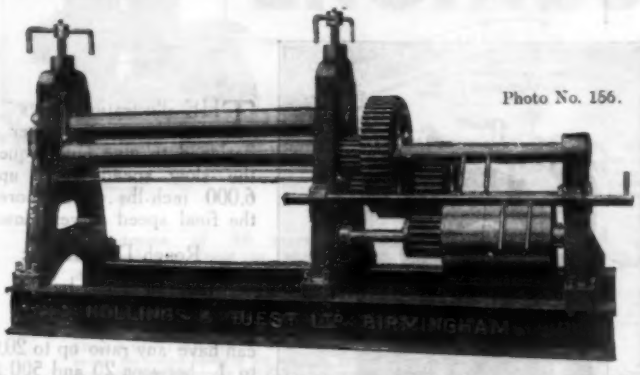

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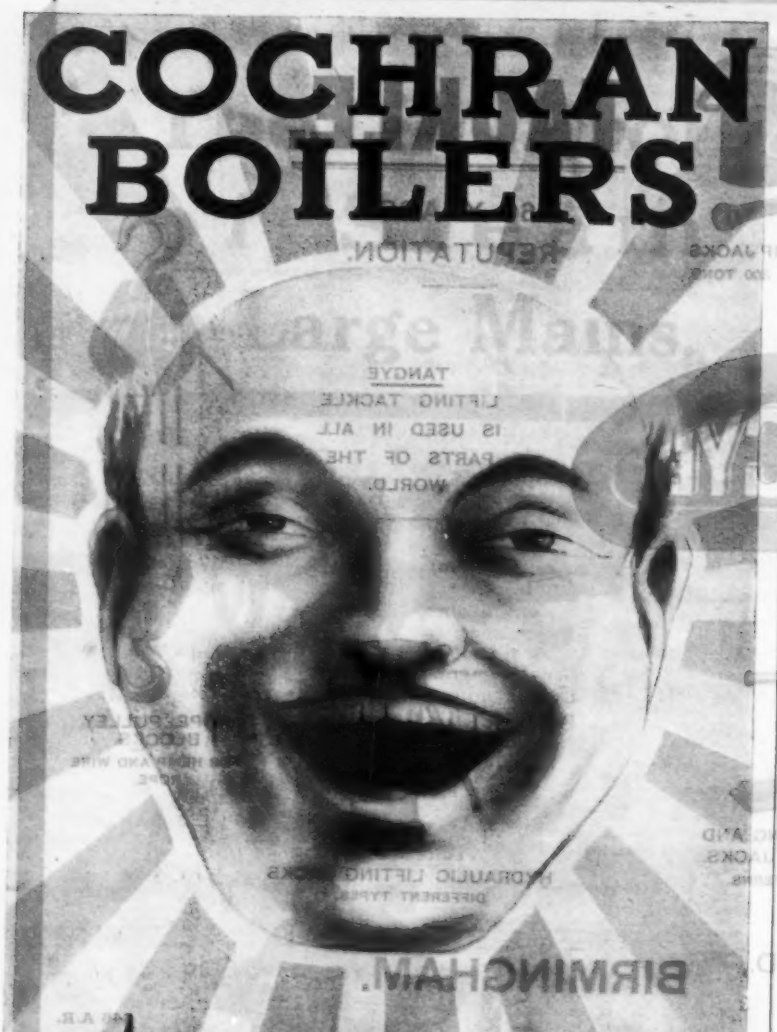

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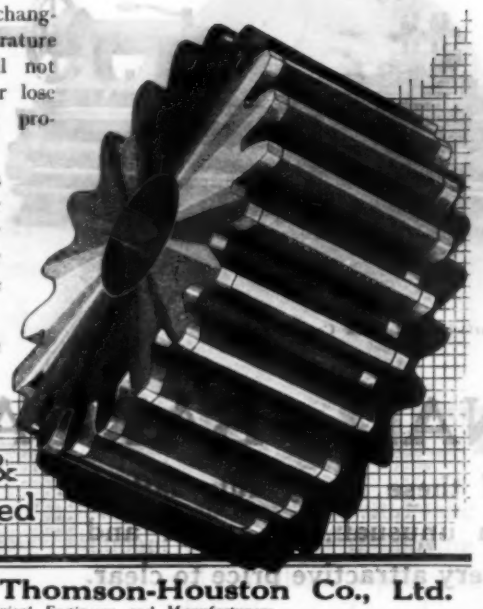

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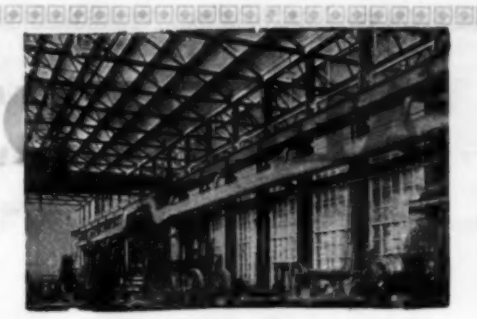

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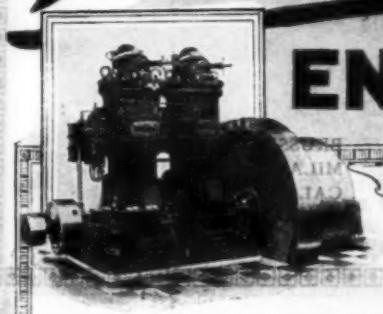

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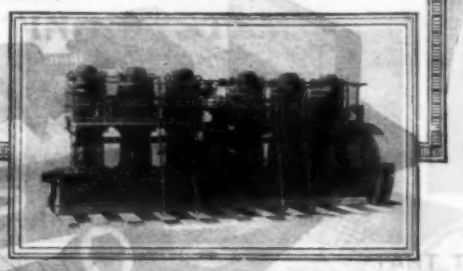

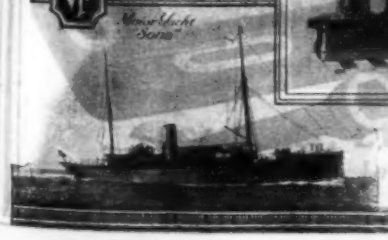

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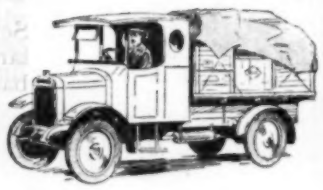

This is the inviting offer we are able to announce in conjunction with the War Office Subsidy Scheme whereby owners of 30-cwt. Thornycroft Subsidy Type Vehicles are entitled to the Subsidy of £120, which is a 25% reduction in the cost of the chassis—an offer you cannot afford to miss.

Chassis with super-cushion tyres; body as specification	£550
War Office Subsidy ...	£120
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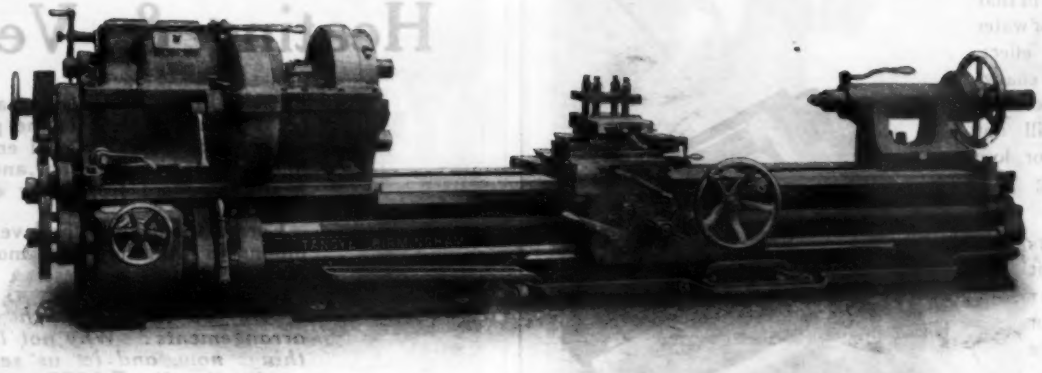

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Length of bed ...	... 18' 0"	**Diameter of hole in spindle** ...	2⅞"
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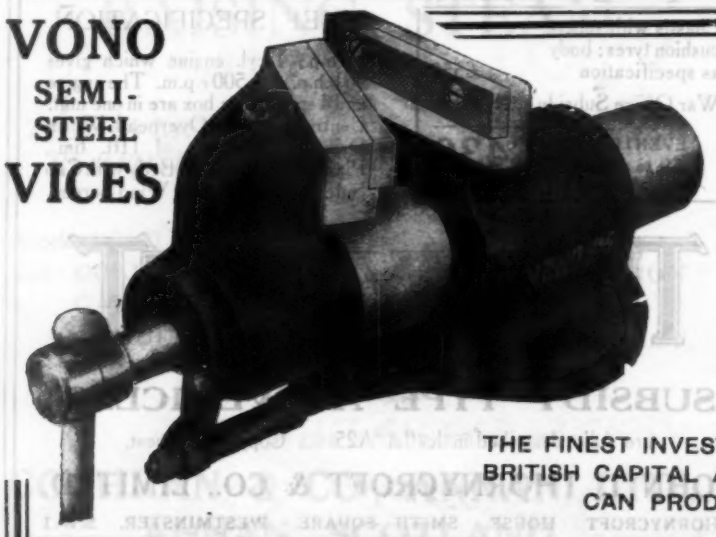

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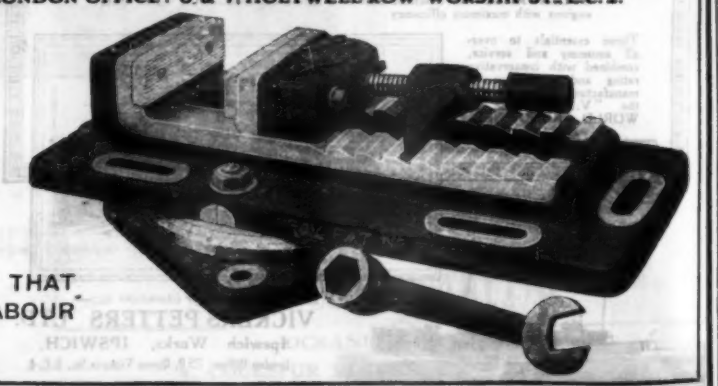

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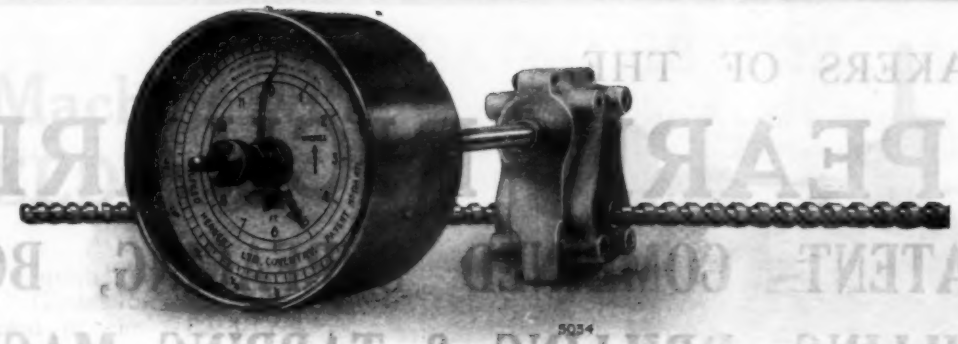

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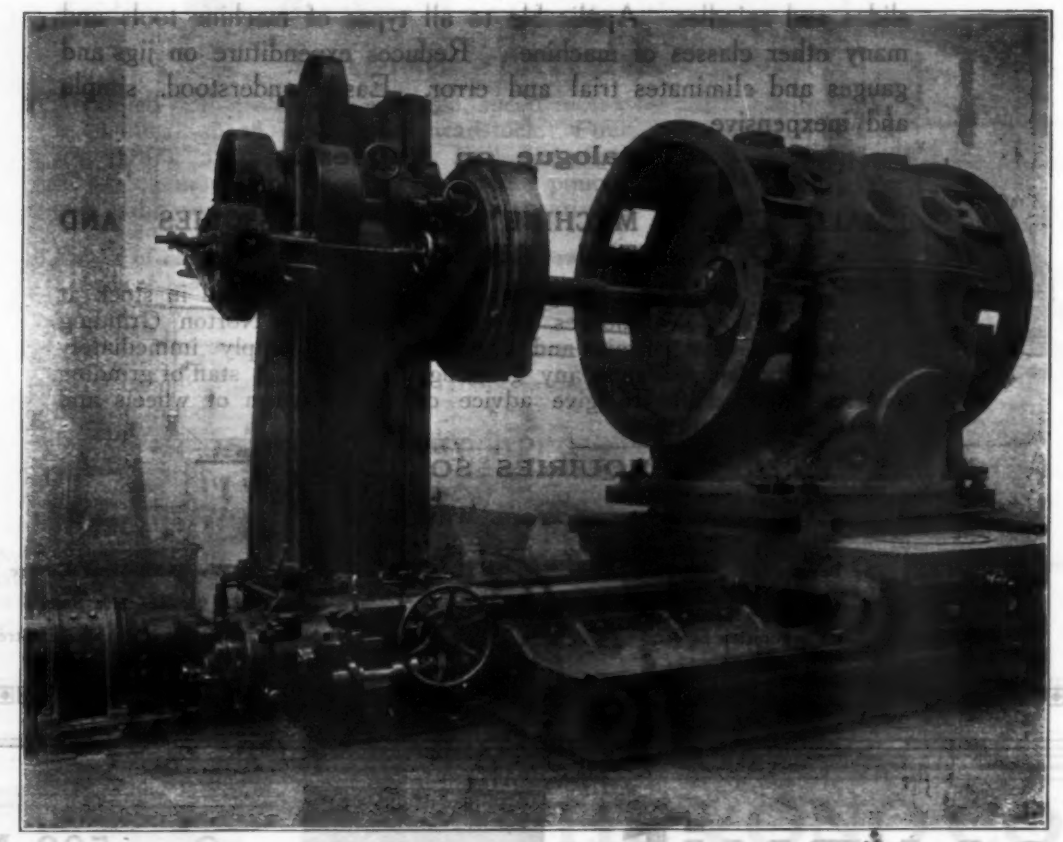

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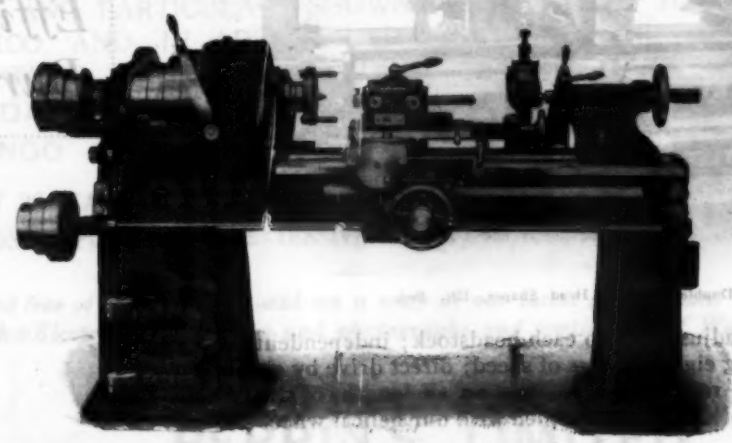

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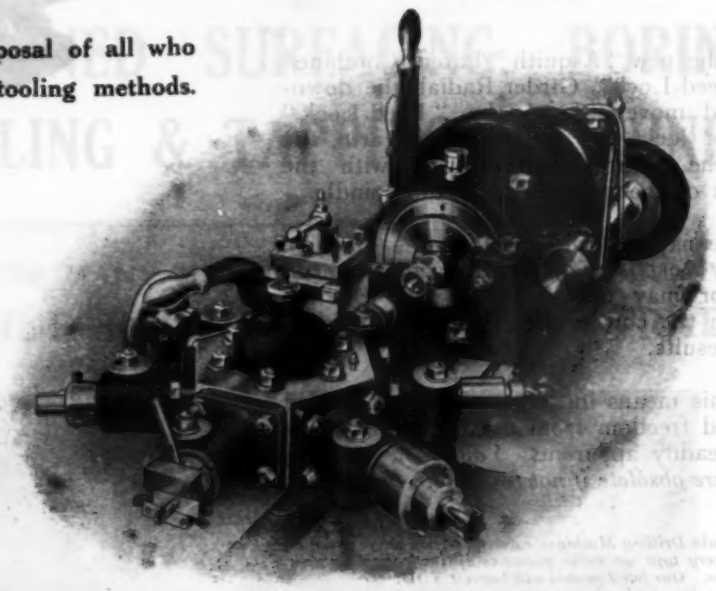

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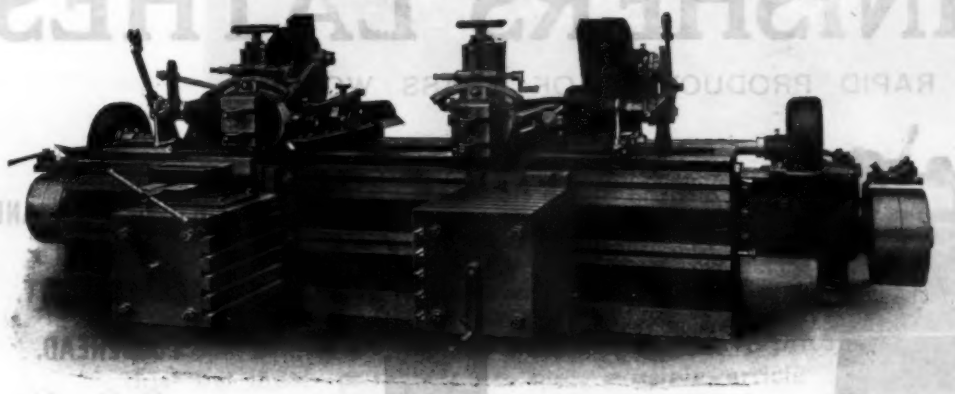

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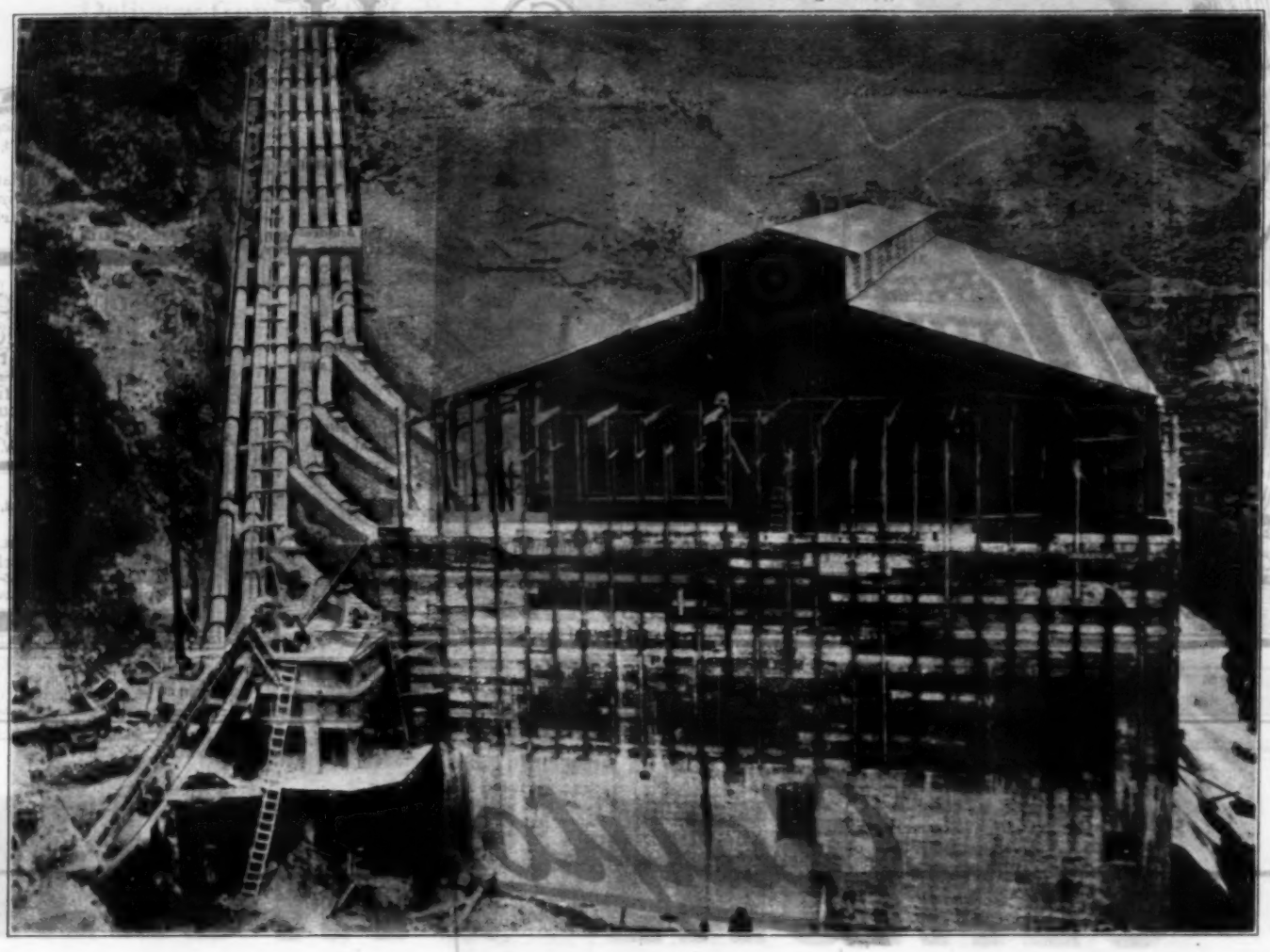

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6	3300	30	1410	FLANGE JOINT.

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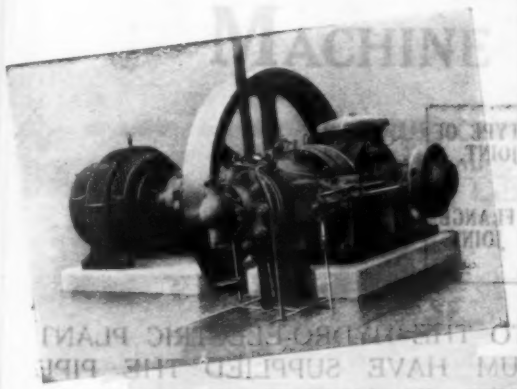

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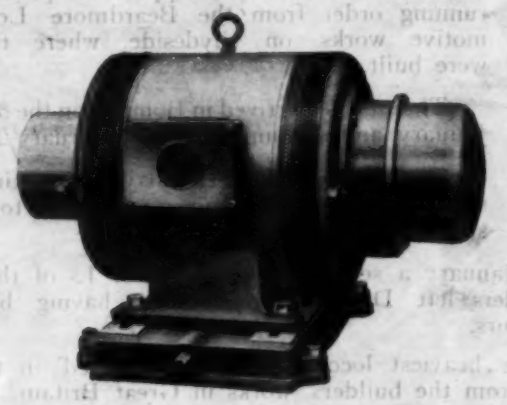

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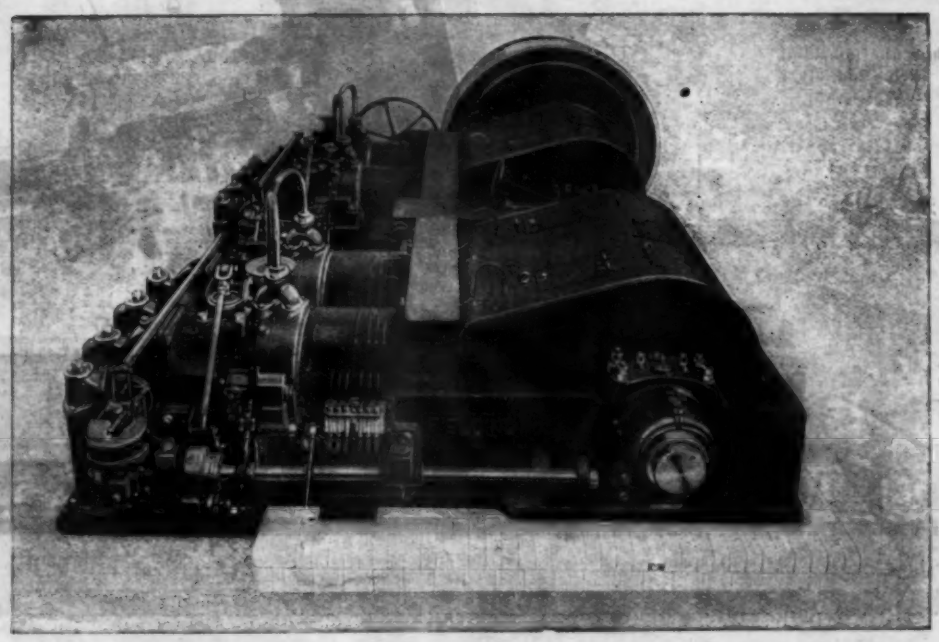

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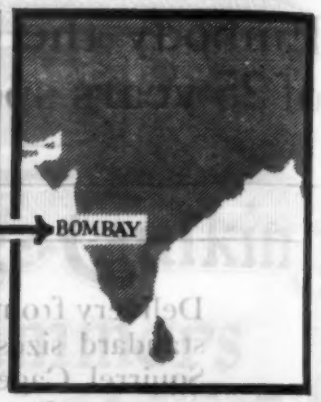

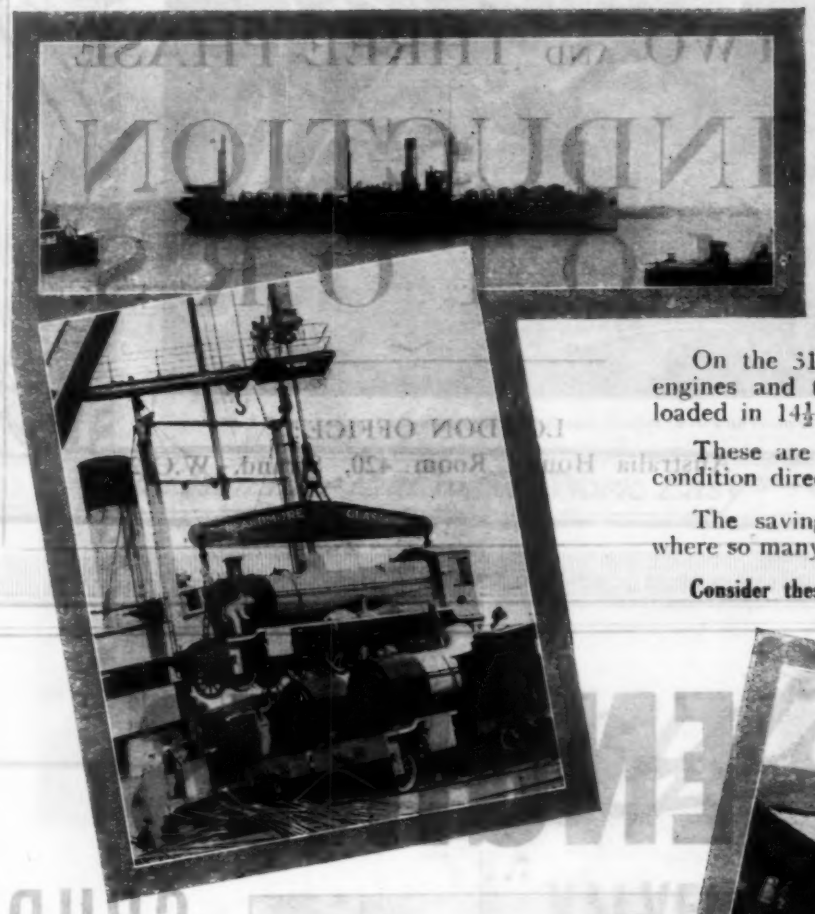

These photos show the unloading at Bombay on Feb. 2nd, 1924.

Our pictures show the arrival at Bombay of 12 passenger express Locomotives for the B.B. & C.I. Ry. shipped complete in running order from the Beardmore Locomotive works on Clydeside, where they were built.

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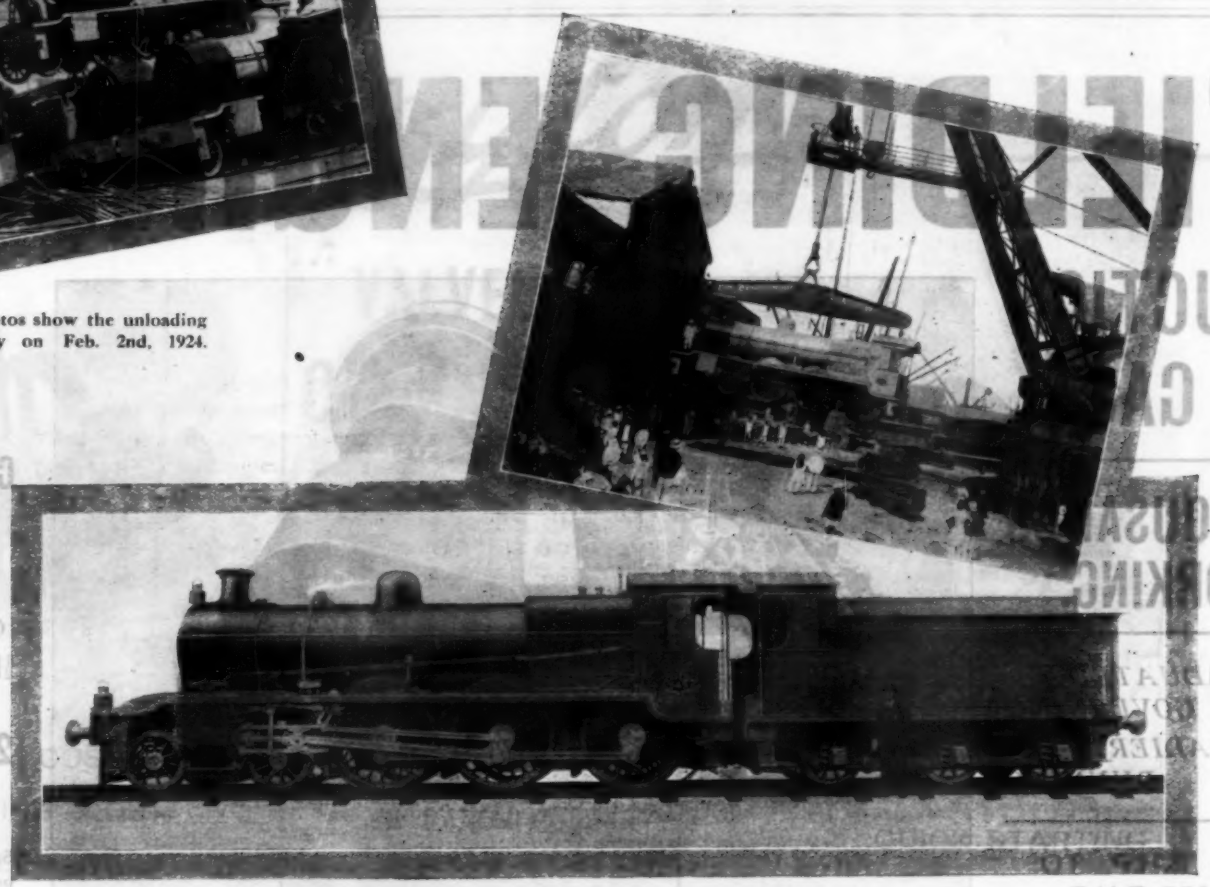

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Locomotive Works: Dalmuir, near Glasgow. **London Office: 36, Victoria St., S.W. 1.**

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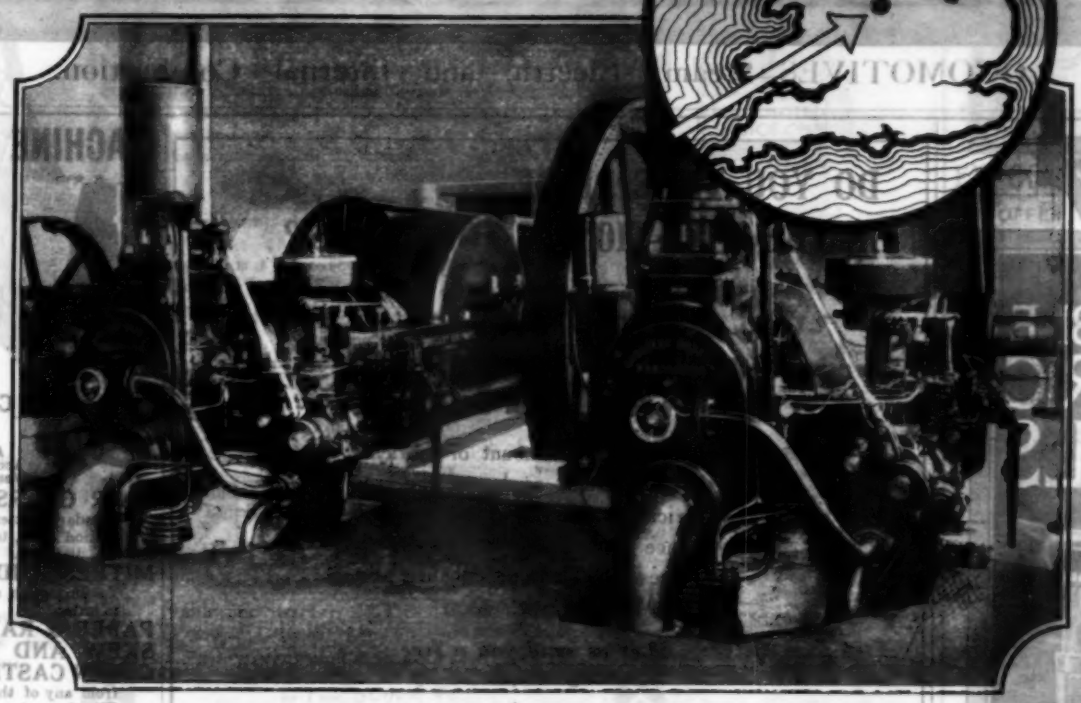

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CRUDE OIL ENGINES from 20 to 500 B.H.P. Also supplied as CONVERTIBLE ENGINES to use either Oil or Gas.

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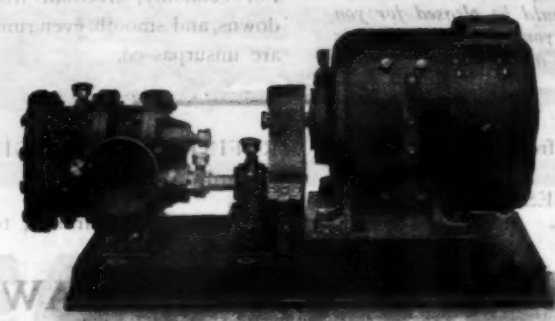

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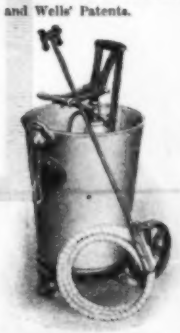

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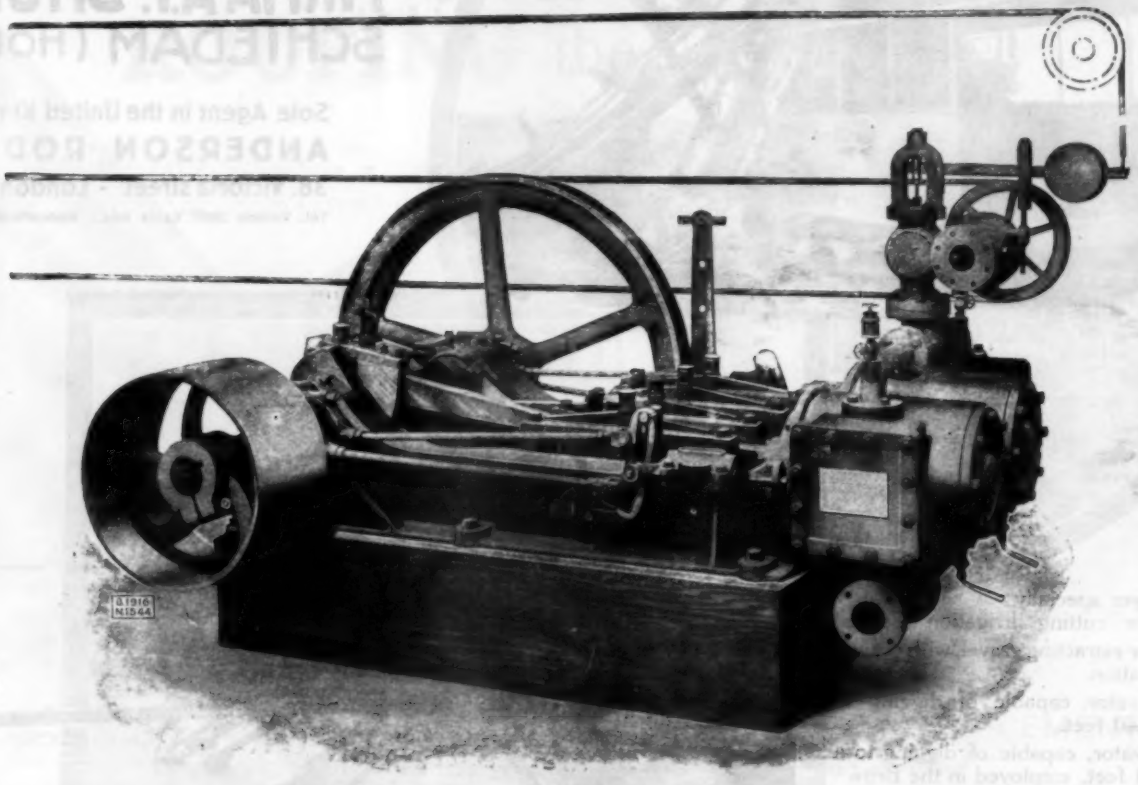

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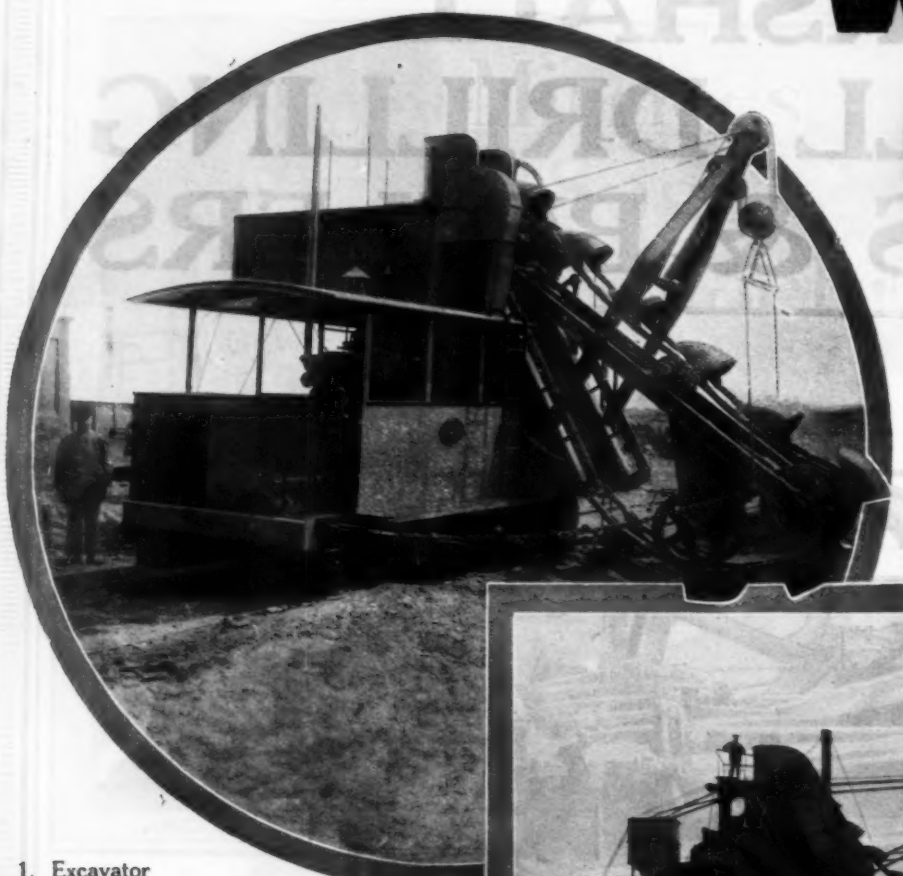

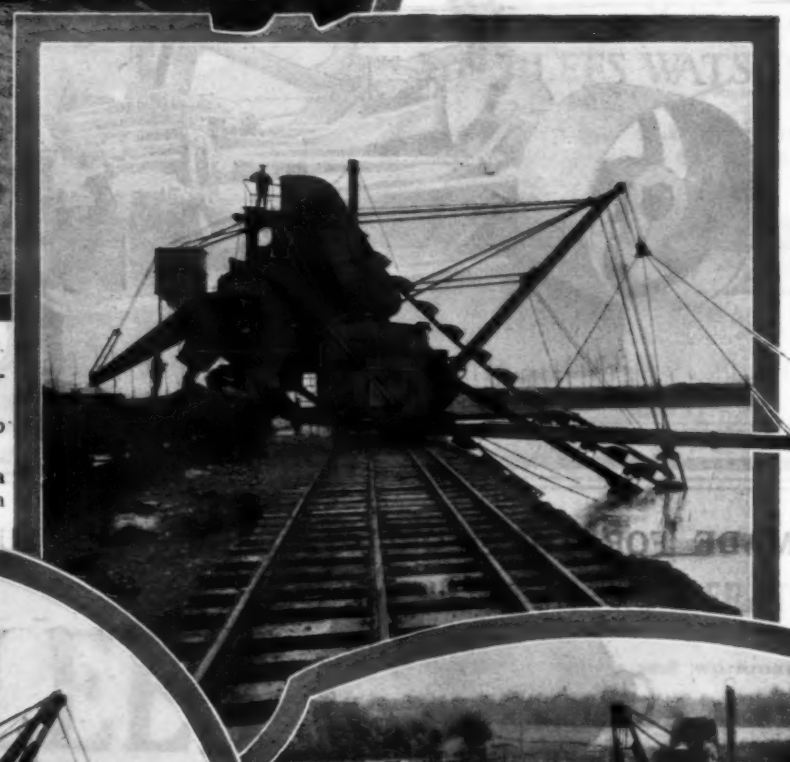

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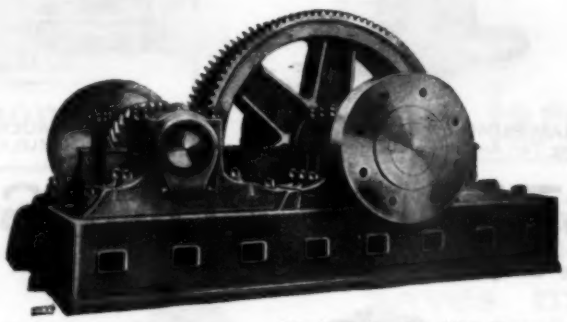

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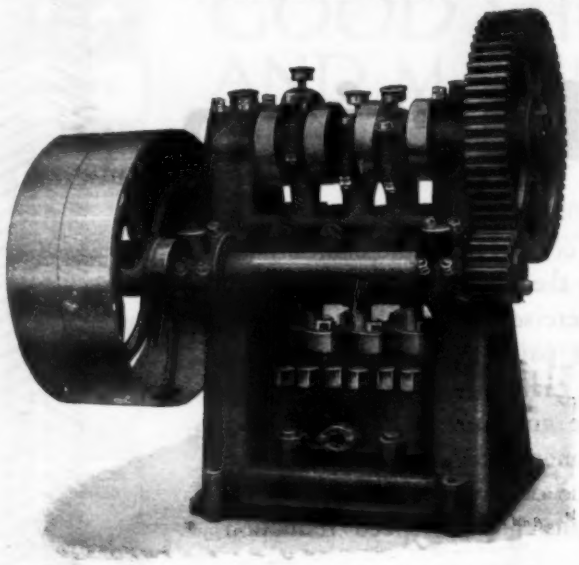

Fig. 7159.—BAILEY'S HYDRAULIC THREE-THROW PUMP. For all pressures and capacities.

160.—RAM PUMP, for Boiler Feeding, Pumping Tar, Ammoniacal Liquor, &c.

Fig. 7161.—HYDRAULIC PUMP AND ACCUMULATOR.

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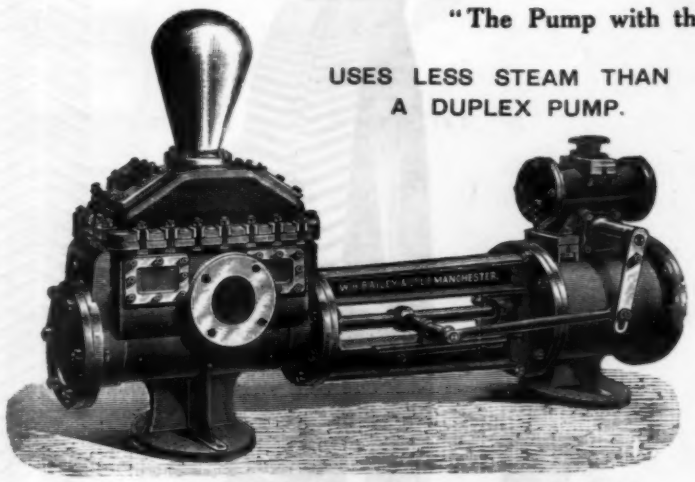

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Fig. 6a D.—"DAVIDSON" HIGH-PRESSURE DOUBLE RAM PUMP. For High Lifts in Mines, &c.

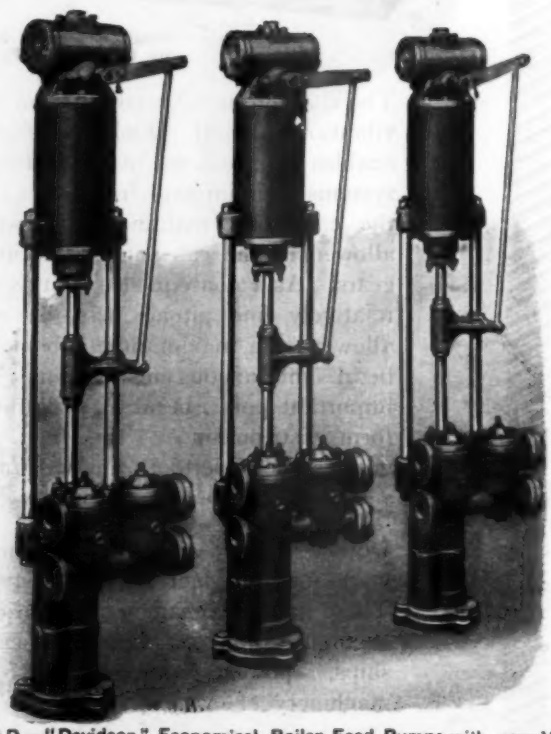

Fig. 50 D.—"Davidson" Economical Boiler Feed Pumps with new Valve Motion, which works without lubrication.

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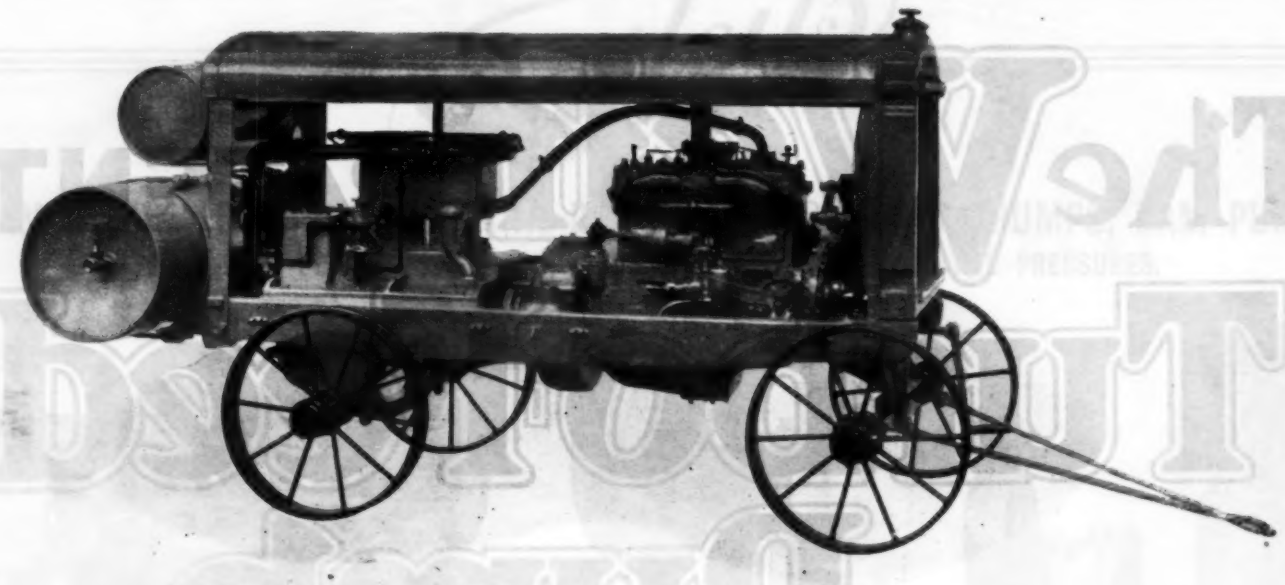

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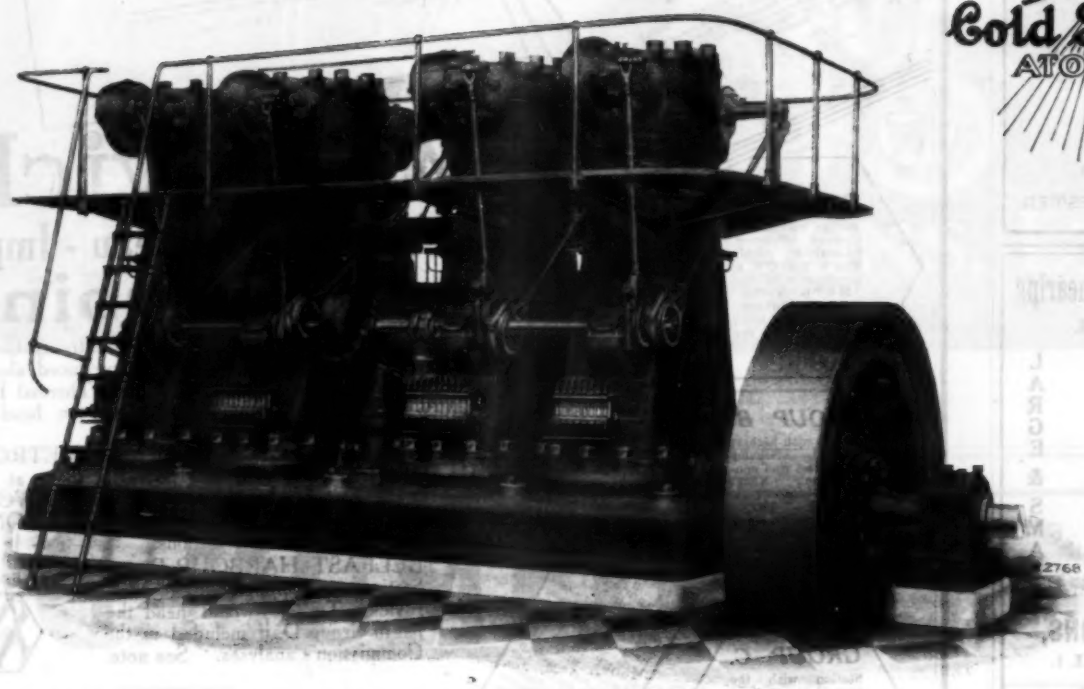

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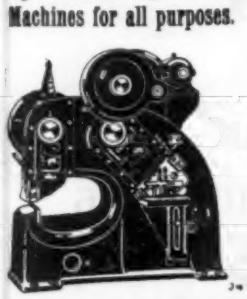

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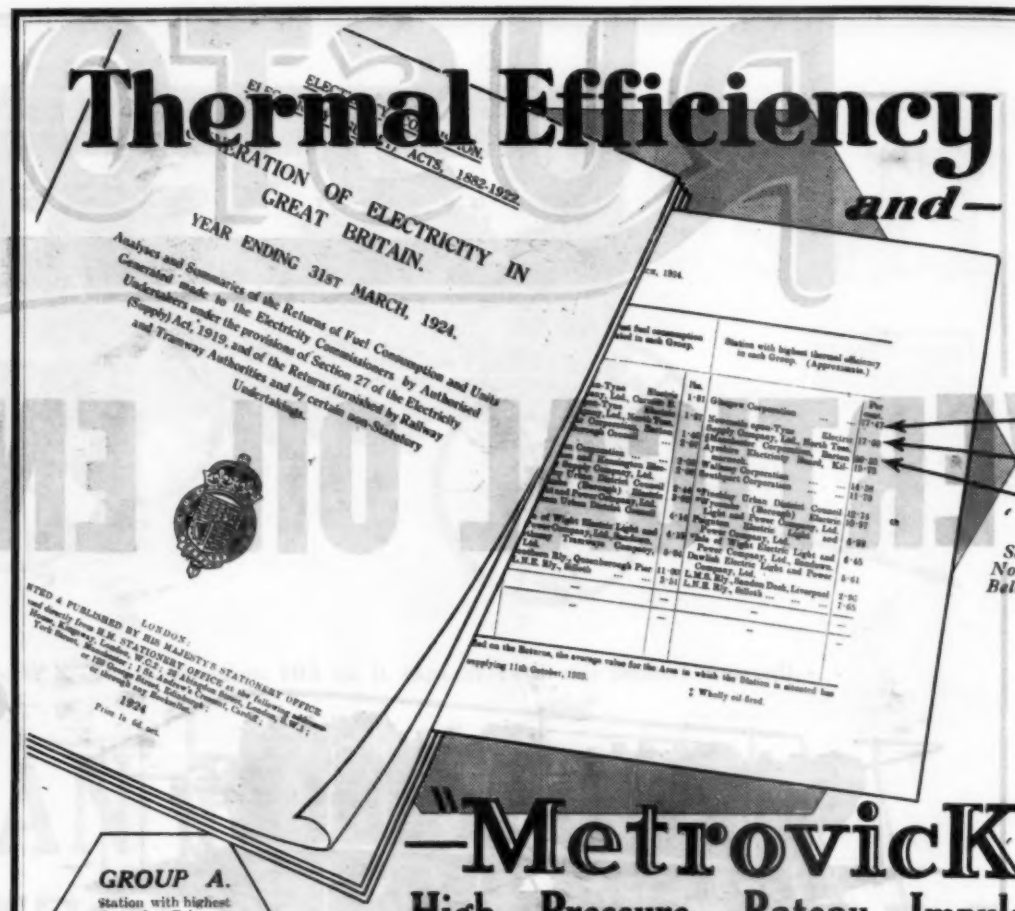
ELECTRICITY ACTS, 1882-1922.
GENERATION OF ELECTRICITY IN GREAT BRITAIN.
YEAR ENDING 31ST MARCH, 1924.
Analyses and Summaries of the Returns of Fuel Consumption and Units Generated made to the Electricity Commissioners by Authorised Undertakers under the provisions of Section 27 of the Electricity (Supply) Act, 1919, and of the Returns furnished by Railway and Tramway Authorities and by certain non-Statutory Undertakings.
LONDON
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GROUP D.
BELFAST HARBOUR STATION being included in the Commission's Analyses, its record would have been shown under GROUP D, as the station with the lowest fuel consumption, and highest thermal efficiency in the group. The 12,500 k.w. "METROVICK" Turbine at present installed takes 89·22 duplicate "METROVICK" Set is nearing completion

THE Analyses and Summaries of the Electricity Commission for the year ending March 31, 1924, reproduced above, gives particulars of the station with the highest Thermal Efficiency in each group; Glasgow, North Tees and Barton head the list in their respective groups.

Each of these three stations is equipped with "METROVICK" RATEAU-IMPULSE STEAM TURBINES, those at Glasgow taking over 60 per cent. of the load, and those at NEWCASTLE (NORTH TEES) and at MANCHESTER (BARTON) taking the entire load of their respective stations.

BELFAST HARBOUR Power Station also equipped with a "Metrovick" Turbine would head the list in Group D, if included in the Commission's analyses. See note.

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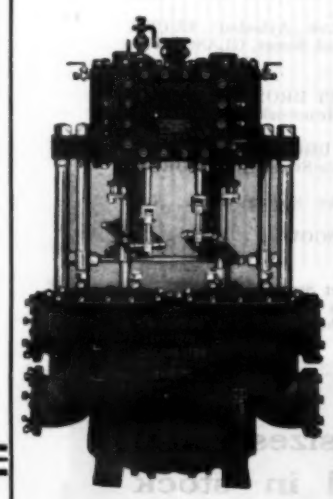

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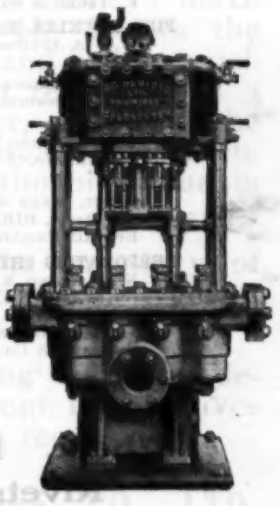

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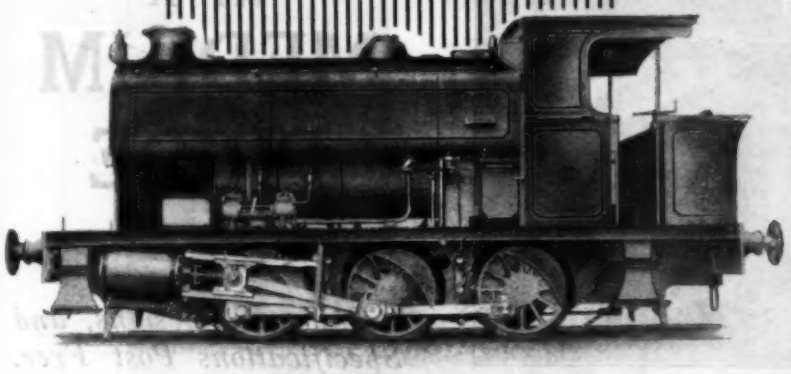

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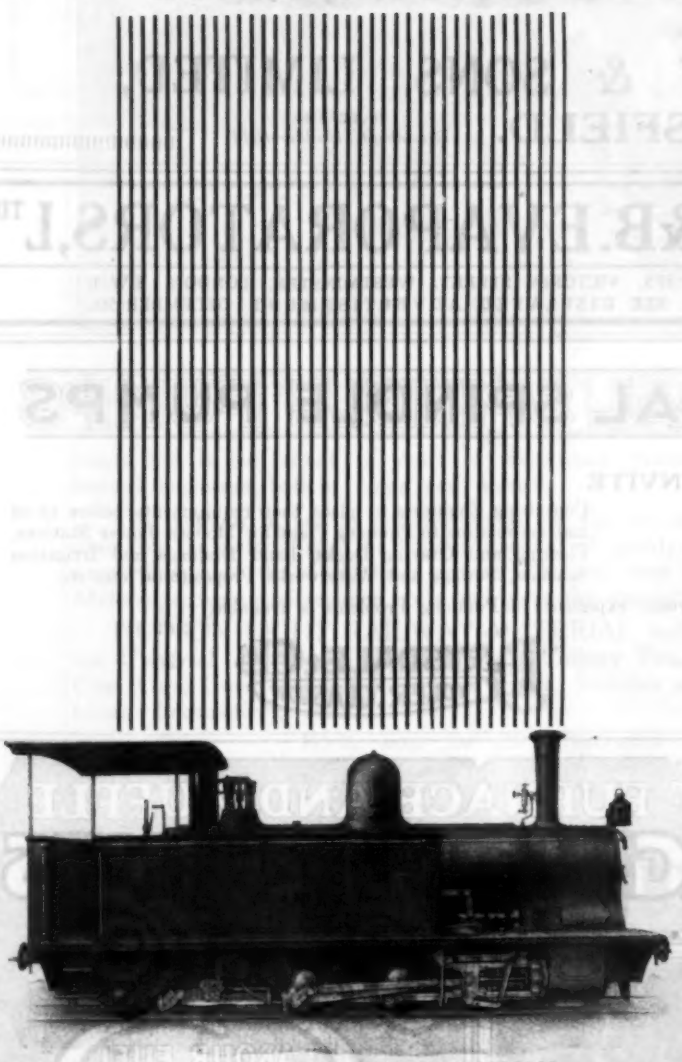

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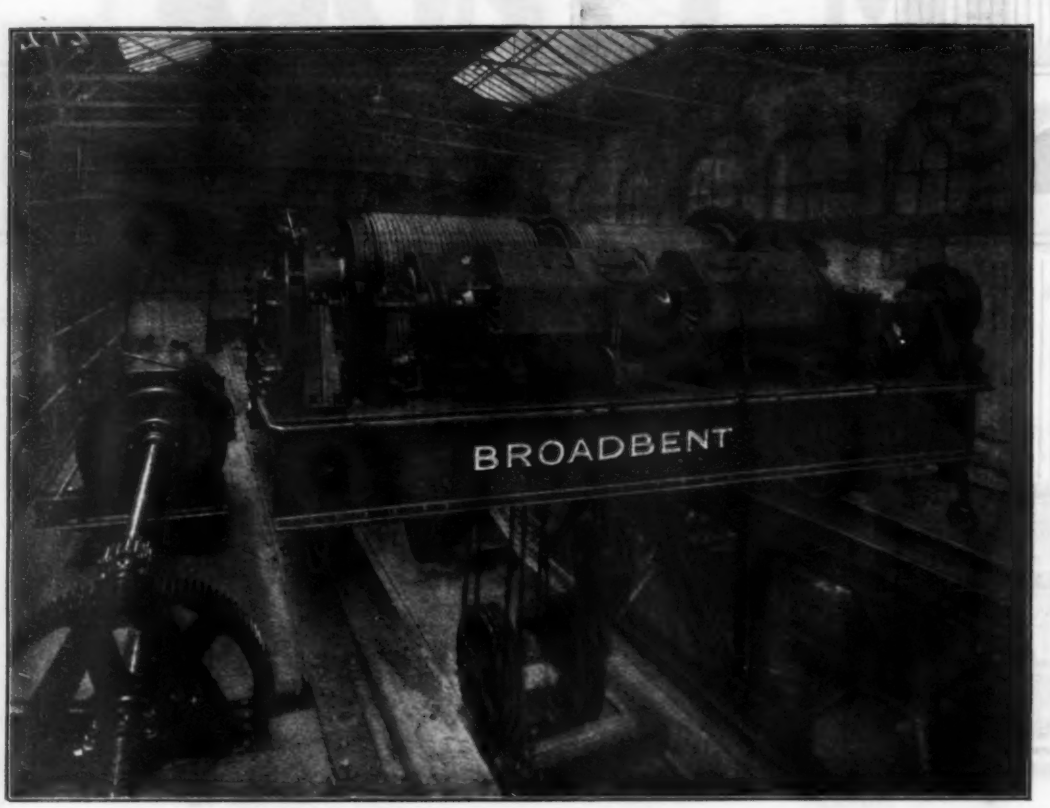

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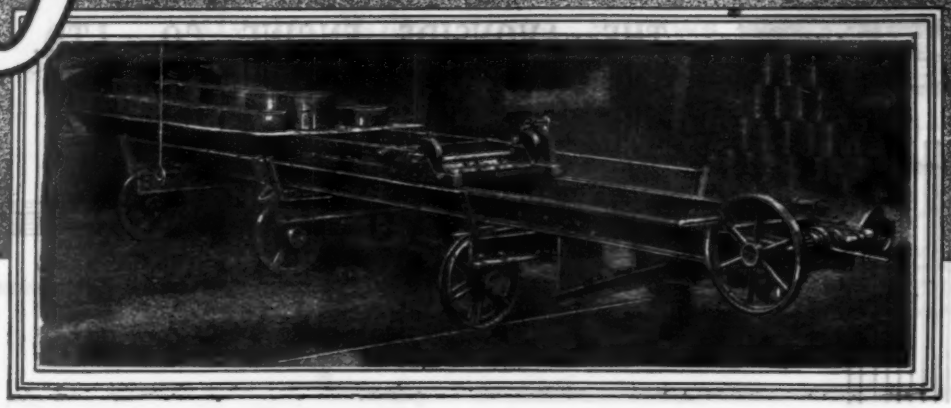

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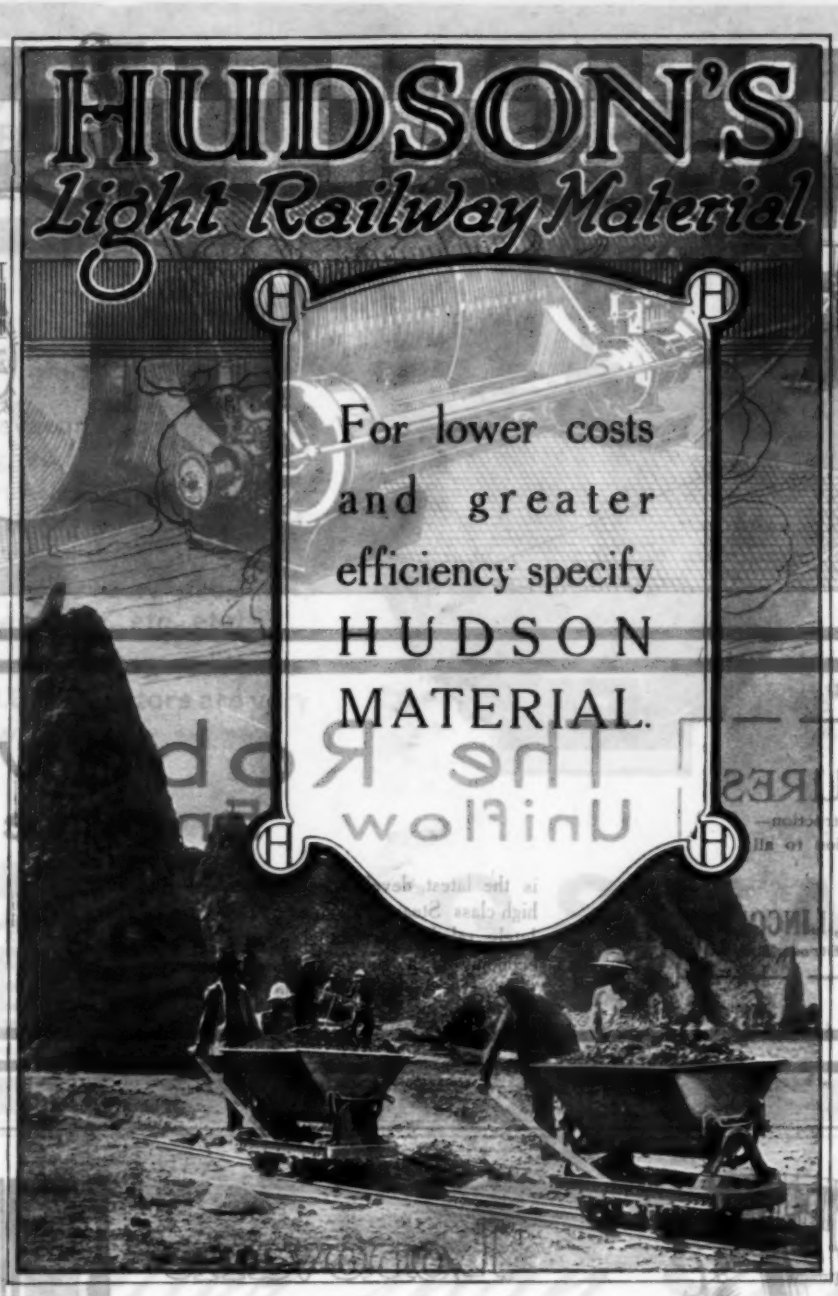

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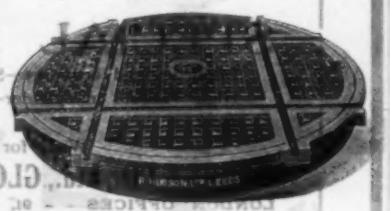

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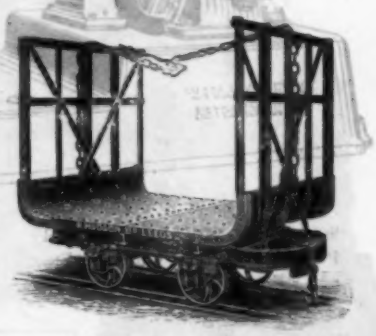

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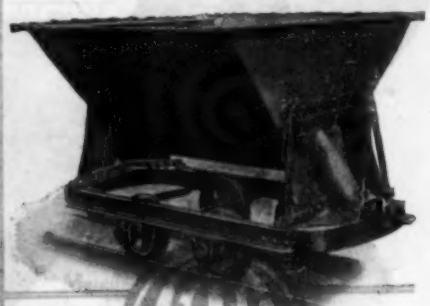

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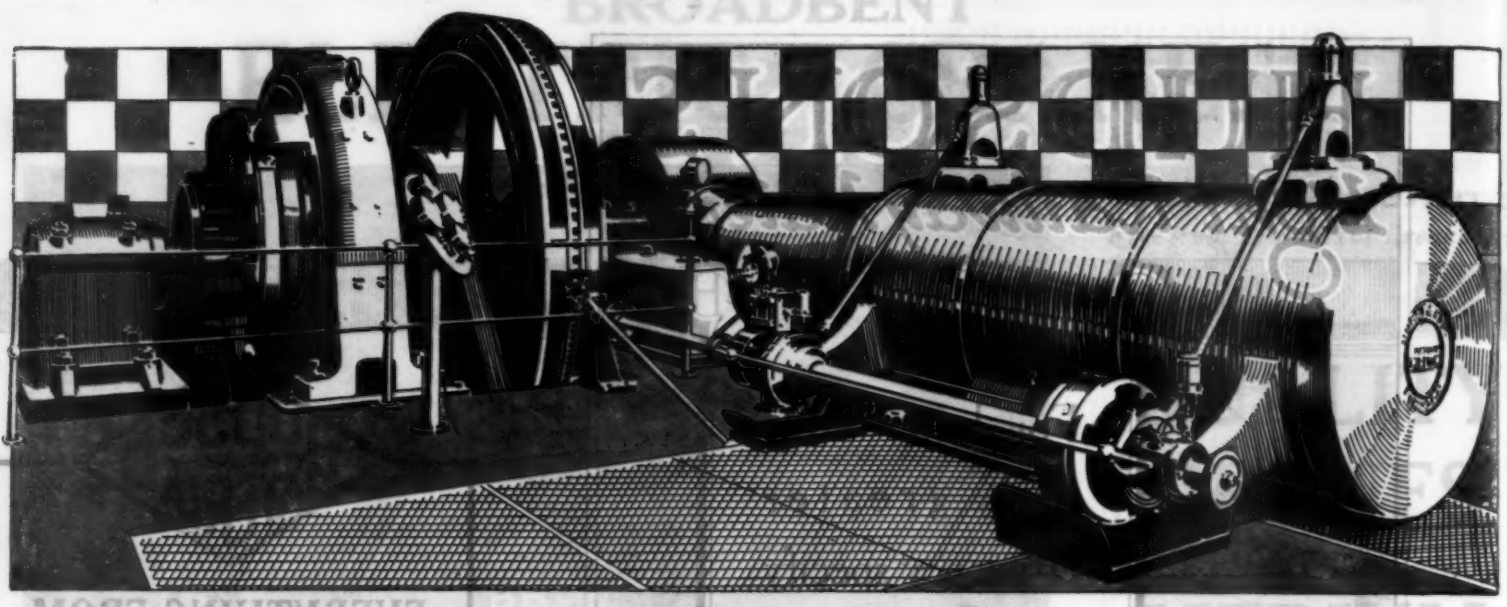

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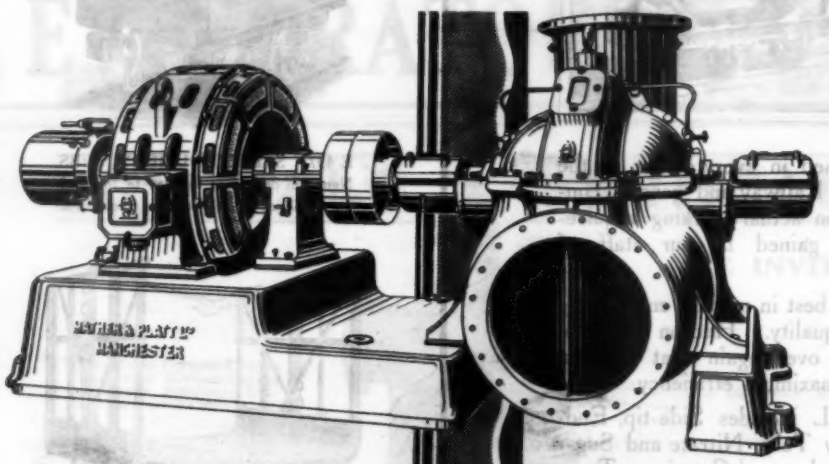

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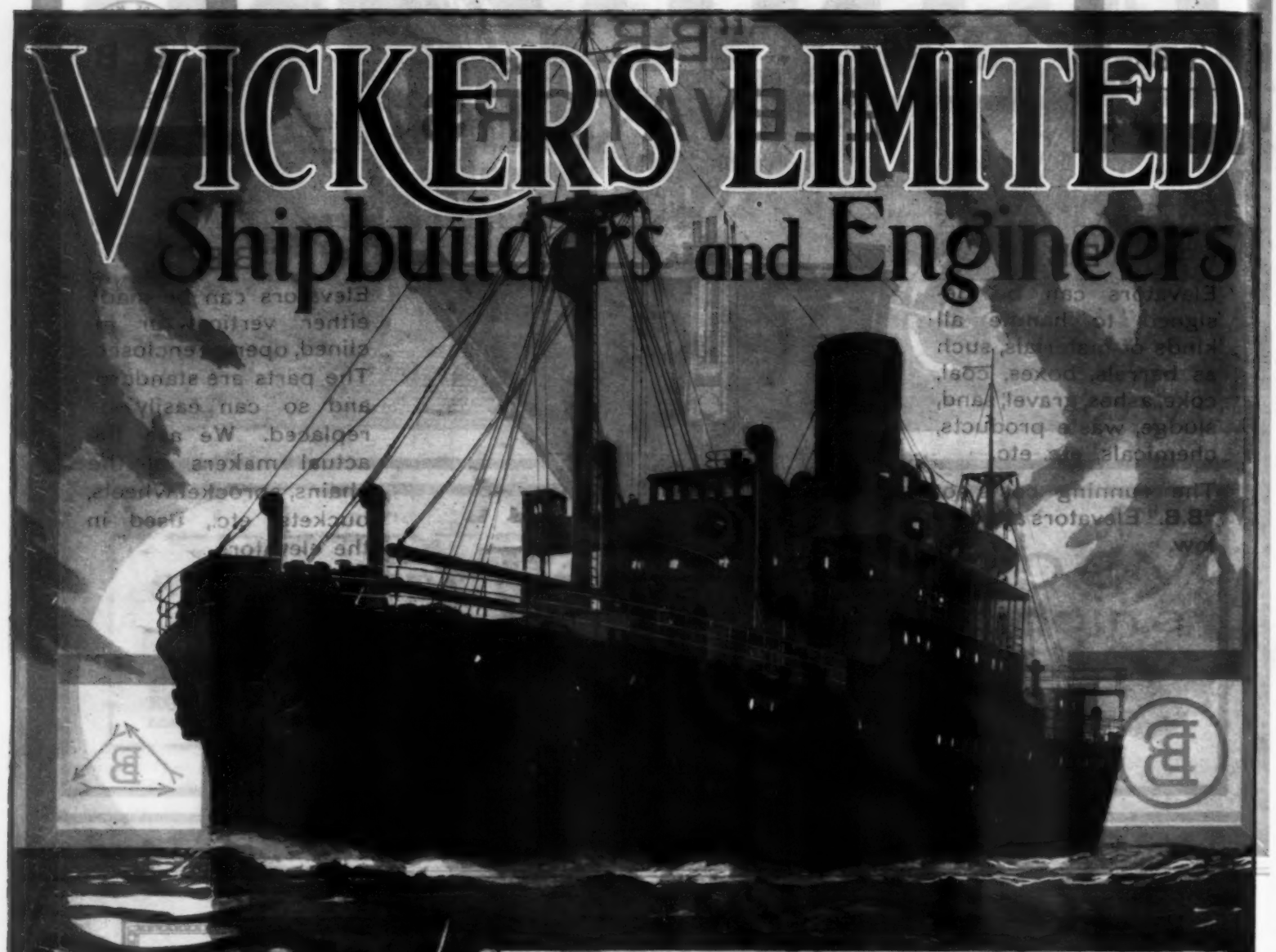

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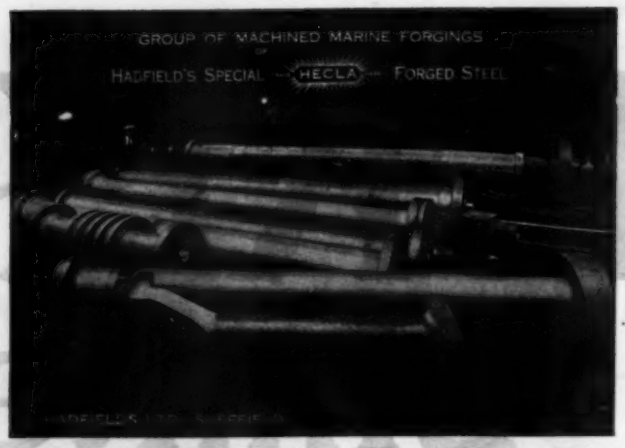

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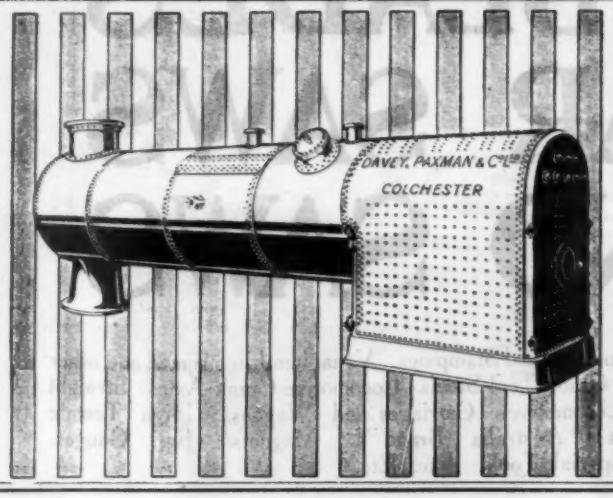

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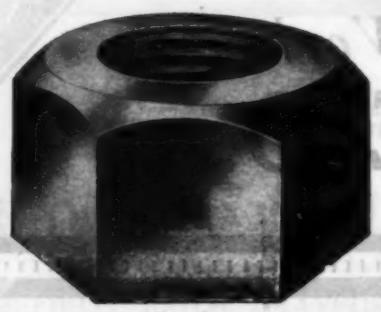

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See Illustrated Advertisement, Dec. 12th, page 20.

DAVIE & HORNE, LTD.,
JOHNSTONE, near GLASGOW.
MAKERS OF
EVAPORATORS, DISTILLING PLANTS, PUMPS, CONDENSERS, FEED WATER FILTERS & HEATERS.
Telegrams: "Evaporator," Johnstone.
LONDON OFFICE: 5, FENCHURCH ST., E.C. 3.

MICHELL BEARINGS, Ltd.,
ENGINEERS & MANUFACTURERS OF
Michell Thrust & Journal Bearings
London Office:
3, Central Buildings, Westminster.
See large Advertisement page 20, Dec. 5th.

COAN CASTS CLEAN CRANK CASES
ALUMINIUM CASTINGS FOR ALL TRADES
SAND OR DIE. ANY SIZE.
ROBERT W. COAN,
210, Gerrard-road, London, N.C.1.
Enquiries invited. Maker of number plates.

ARMCO

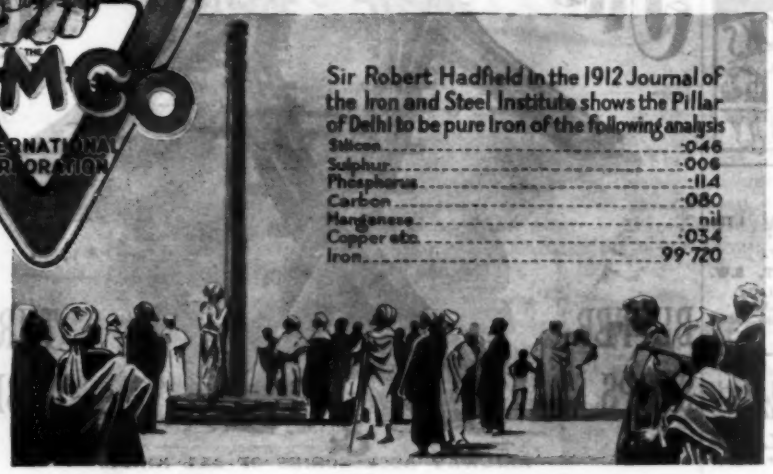
REGD TRADE MARK

Ingot Iron

Chemical Purity

TRADE MARK.

BRITISH MADE


Sir Robert Hadfield in the 1912 Journal of the Iron and Steel Institute shows the Pillar of Delhi to be pure Iron of the following analysis
Silicon :046
Sulphur :006
Phosphorus :114
Carbon :080
Manganese nil
Copper etc. :034
Iron 99·720

Iron Pillar at Delhi, which is 1600 years old, is shown to be 99.72% Pure Iron, whereas "Armco" Ingot Iron is 99.84% Pure Iron.

The durability of long lasting iron is the result of extreme purity, which is clearly emphasised by the Iron Pillar at Delhi and other examples of ancient iron. Purity in iron means longer life.

In the manufacture of "Armco" Ingot Iron chemical purity is the first consideration; from the selection of raw materials right to the finished product every care is taken to produce a commercially pure iron of outstanding quality.

The elimination of impurities in the manufacture of "Armco" Ingot Iron as shown by analysis results in the production of Ingot Iron containing less than one-sixth of one per cent. of impurities, taking into consideration Silicon, Sulphur, Phosphorus, Manganese, Carbon, Copper and the gases Oxygen, Hydrogen and Nitrogen.

Other important qualities, such as Rust Resistance, Electrical Conductivity, Enamelling and Welding properties, are linked with the Chemical Purity of "Armco" Ingot Iron.

"ARMCO" INGOT IRON IS UNIFORM IN TEXTURE AND ANALYSIS.

For further information write to

The Armco International Corporation,

Pinner's Hall, Old Broad Street, - - - London, E.C. 2.

Telephone: London Wall 5771. *Telegrams: Armcoingot, Stock, London.*

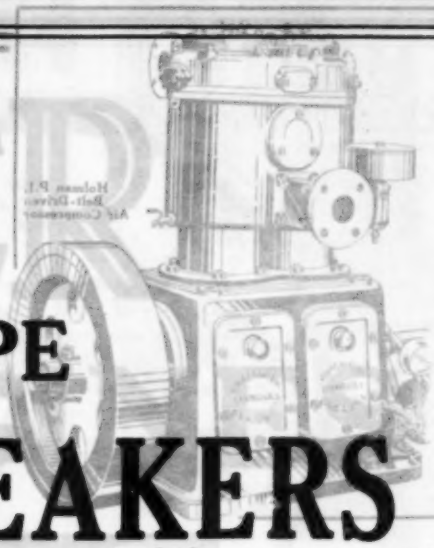
LICENSEES AND AGENTS IN GREAT BRITAIN.—Ingot Iron is made in Great Britain for the Armco International Corporation by the Shelton Iron, Steel & Coal Co., Ltd., and The Scottish Iron & Steel Co., Ltd. By exclusive arrangement The Scottish Tube Co., Ltd., is the Sole producer of butt-welded and lap-welded Tube and Pipe from "Armco" Ingot Iron. The Whitecross Co., Ltd., is by like arrangement the Sole producer of Rods, Wire, Welding Electrodes and Cold Rolled Strip, from "Armco" Ingot Iron. Tyer & Co., Ltd., are Sole Selling Agents for Railway Companies for all British Made "Armco" Ingot Iron Products, excluding butt-welded and lap-welded Tube and Pipe.

REGD. TRADE MARK

AHONEIL

G.E.C.

OUTDOOR TYPE
OIL CIRCUIT BREAKERS



For Circuits of 33,000 Volts and upwards.

G.E.C.
44,000 volt
Outdoor type
Oil Circuit Breaker.

Contacts in open position.

EVERY DETAIL IS DESIGNED TO ENSURE THE PRODUCTION OF A MOST RELIABLE AND EFFICIENT BREAKER.

2.—The Contacts.

FIXED CONTACTS consist of pairs of copper fingers having controller type contact faces.

The current carrying capacity of surfaces of this rounded form have been shown by exhaustive tests to be superior to flat faced contacts of the same size.

Contact pressure is increased due to contacts being in pairs, owing to electro-magnetic attraction during overload, thus **heavy overloads do not tend to separate the contact faces before the breaker opens.**

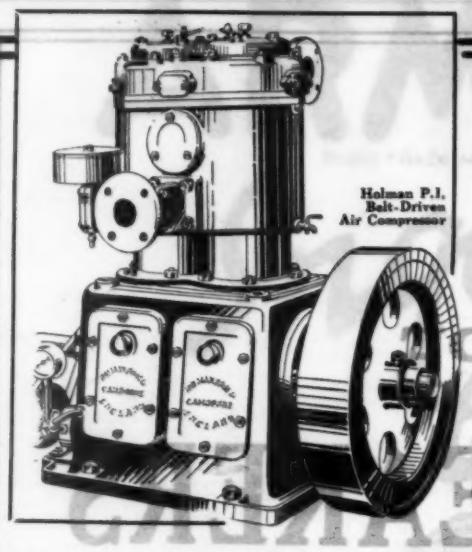
MOVING CONTACTS of wedge pattern suspended on steel rods and insulated by condenser type bakelite bushings.

THE GENERAL ELECTRIC CO. LTD.

Head Office: MAGNET HOUSE, KINGSWAY, LONDON, W.C. 2.

Engineering Works { **WITTON WORKS, BIRMINGHAM.**
Fraser & Chalmers Engineering Works, Erith, Kent.

REGD TRADE MARK. REGD TRADE MARK.



The Holman 'P.I.' Compressor

reduces costs while increasing production

Designed to increase output and to cut costs and overhead expenses, the P.I. Air Compressor effects an appreciable saving: every point has been studied in order that working expenses are reduced to their minimum, while the over-all efficiency and reliability of the machine has been enormously increased.

The Holman Vertical Piston Inlet type of Air Compressor incorporates an automatic air control valve regulating free air supply in accordance with the varying demands of the receiver, ensuring great economy in Motive Power. It is fully worthy to uphold the Holman reputation. Write for particulars to-day.

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No. 662.—100 h.p. WORM AND SPUR GEARED SINGLE ENDLESS ROPE HAULAGE GEAR. Cast-Iron Bedplate.

A massive and compact type of Haulage for heavy continuous work. Reduction Gear is partly by means of Worm Gear and partly of Double Helical Toothed Gears, the best combination for this class of work. Wormshaft is mounted on Anti-friction Roller Journal Bearings, whilst Double Ball Thrust Bearings are fitted to both Worm and Worm Wheel Shafts, ensuring frictionless running.

Bedplate is built in sections, machined and bolted together for easy handling. An Electro Mechanical Brake is fitted to Drum formed on Wormshaft half of Flexible Coupling, to prevent running back in the event of current failing at the same time as load is unbalanced. A hand-operated Brake is also fitted to Drum

Electrical Equipment may be of any approved make to comply with H.O. Regulations for the use of Electricity in Mines.

Made in all sizes from 75 h.p. to 400 h.p.

AGENTS FOR SCOTLAND:
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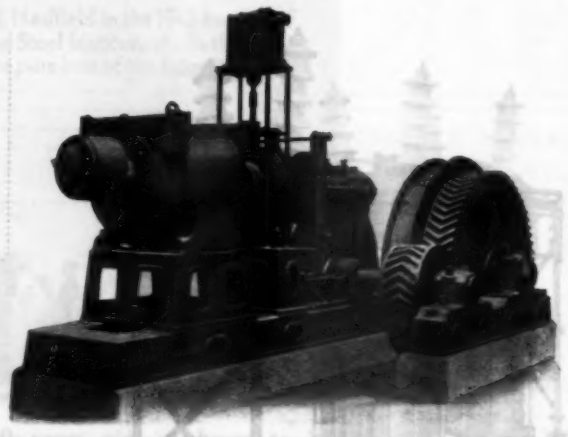
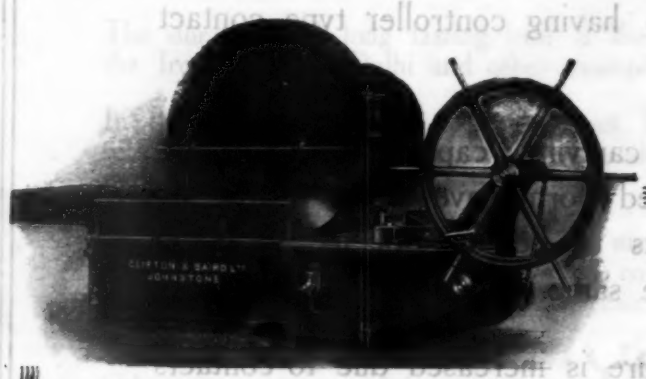
Haulage Gear Pamphlet No. 32 R post free.

CARRON COMPANY FOUNDED 1759 ENGINEERING DEPARTMENT, CARRON, STIRLINGSHIRE.





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FRICTION SAWING MACHINE
For Output and Economy.

Supplied to the leading Shipyards and Structural firms.

Friction Sawing is the cheapest method of sawing all Structural Sections.

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Bridge Builders and Constructional Engineers.

SPECIALISTS IN DEEP FOUNDATION WORK.

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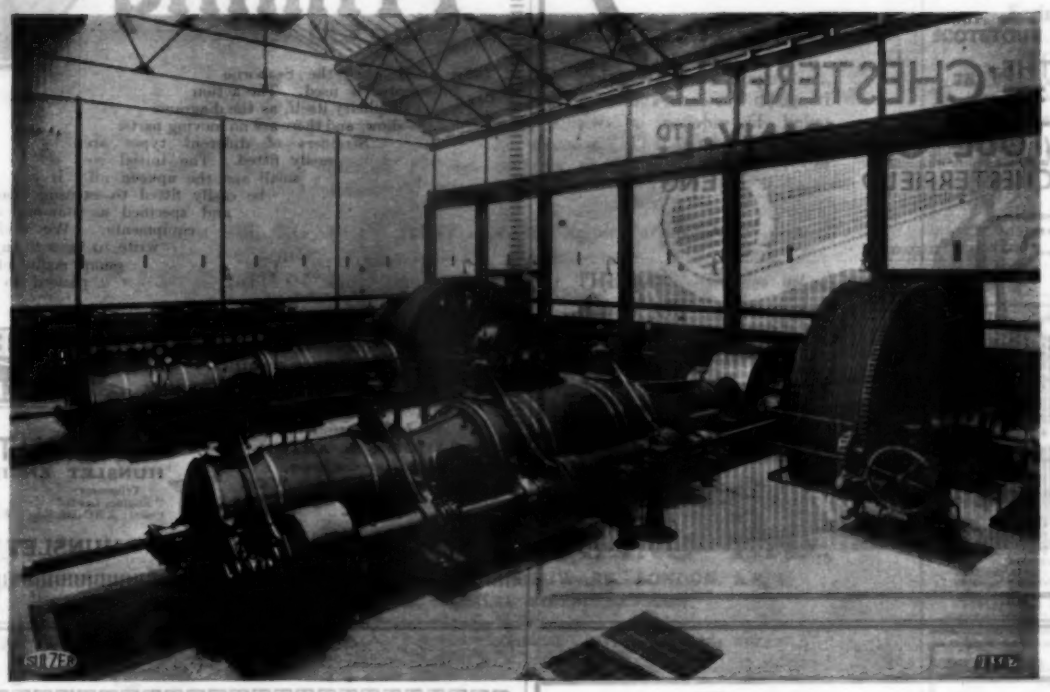
SULZER
STEAM ENGINES



Two Sulzer 2000 BHP Tandem Steam Engines in the Paper Mills of Messrs. Thomas Owen and Co., Cardiff.
Admission pressure 240 lbs./sq. in., quantity of steam extracted per hr., up to 25,000 lbs., at a pressure of 80 lbs./sq. in.

For

HIGH EFFICIENCY,
EXTREME RELIABILITY,
CLOSE GOVERNING,
SILENT RUNNING.

Uniflow Steam Engines ..... **For Power Purposes Alone.**

Back Pressure Engines | **For Heating & Process Work**
Steam Extraction Engines | **in addition to Power.**

OTHER LEADING SPECIALITIES:

Boilers and Superheaters; Stationary and Marine Diesel Engines;
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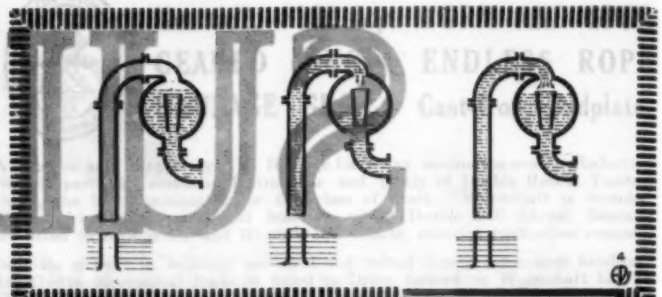
The superiority and increased all-round efficiency of Cold Drawn products has led to an enormous demand for Chesterfield Cold Drawn Seamless Tubes. These are now made from ¼in. up to and including 24in. diam., and to meet the requirements of Steam Pipes, Boiler Tubes, and all Engineering purposes.

On Admiralty and War Office lists.

THE CHESTERFIELD TUBE COMPANY LTD. CHESTERFIELD ENG



No Hand Priming

Is required when the Seaborne Interceptor is used. The action is simplicity itself, as the diagrams show, and there are no moving parts. Strainers of different types are easily fitted. The initial cost is small and the upkeep nil. It can be easily fitted to existing plants and specified as standard on new equipments. We invite you to write to us or to any of the leading pump manufacturers who will be pleased to tell you all about the

Although only recently placed on the market there are already many installations fitted both at home and in foreign countries.

Patented at Home and Abroad.

SEABORNE INTERCEPTOR

London Agency:
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Telegrams: "Agrigenic, Estrand, London."
Telephone: City 8125.

THE HUNSLET ENGINE CO. LTD.
HUNSLET ENGINE WORKS, LEEDS.
Telegrams: "Engine, Leeds." Telephone No. 20677 (2 lines).
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ALSO MANUFACTURERS OF "HUNSLET" LOCOMOTIVES.

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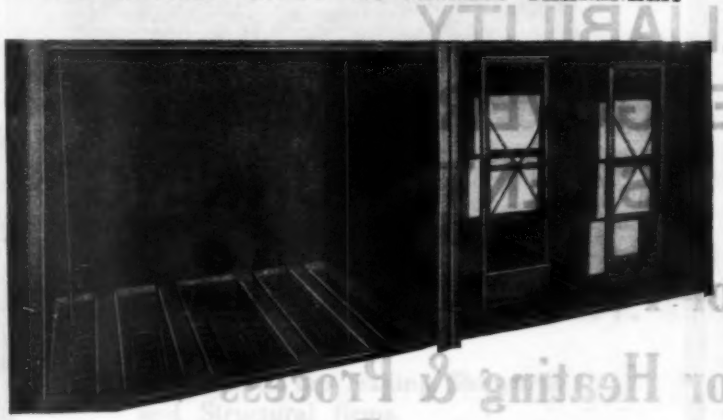
THE PERKINS SMALL BORE SYSTEM OF HEATING FOR ENAMELLING, JAPANNING, TINPLATE PRINTING, COLOUR DRYING, CHEMICAL DRYING, ETC., AT TEMPERATURES UP TO 350 DEGREES FAHRENHEIT



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ABSOLUTELY DRY AND CLEAN HEAT.
TEMPERATURES QUICKLY OBTAINED.
NO SKILLED ATTENTION REQUIRED.
PERFECT EQUALISATION OF HEAT.
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WORKS . . . WILLESDEN AND PETERBOROUGH.

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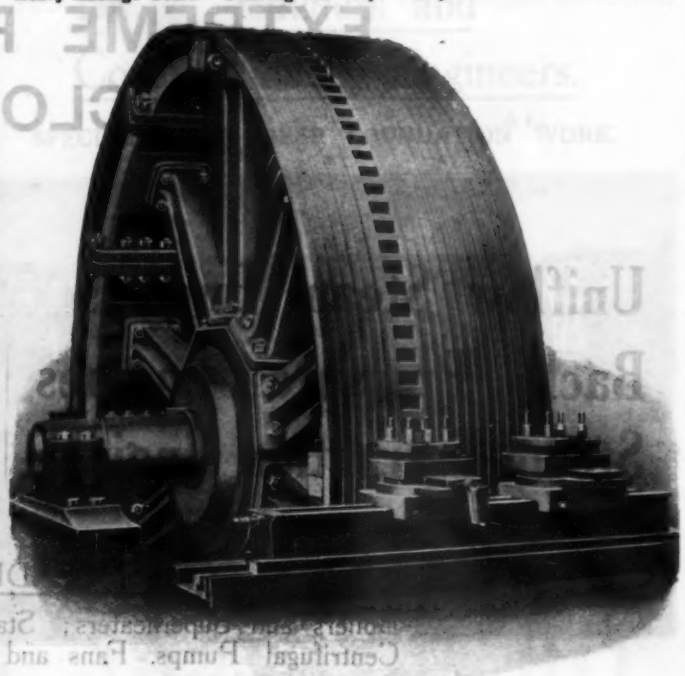
Totally enclosed Worm and Spur Reduction Gears.
Machine Moulded and Machine Cut Wheels, any Size and Material.
Heavy Haulage Gears. Shafting and Rope Pulleys for Mills and Factories.



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Associated with
FAIRBAIRN LAWSON COMBE BARBOUR, LTD., LEEDS.
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BLACKNESS and WALLACE FOUNDRIES, DUNDEE.

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When you want efficient service and the best quality goods, remember WALWORTH. MUNZING.

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In these days of high labour cost and strenuous competition, you cannot afford to be satisfied with fittings that are designed merely for appearance; they must also be capable of being installed with the least possible expense. That is why Walworth Malleable Banded Fittings embody these points which are of distinct advantage to you:—

STRONG FLAT BAND.—*Ample support at point of greatest strain.*
BRITISH STANDARD TAPERED THREADS.—*Always get a joint.*
THREAD OPENINGS CHAMFERED.—*No burred threads to waste time starting tube.*
RECESS AT BACK OF THREAD.—*No shoulder to interfere.*
EVERY FITTING TESTED TO 300 lbs.—*No leaks.*
LARGE STOCK.—*Immediate delivery.*

Write to Dept. E. for Catalogue 61.

WALWORTH-MUNZING LTD.,
90-96, UNION STREET, SOUTHWARK, LONDON, S.E. 1,
and 209, BERKELEY STREET, GLASGOW.

We can make PROMPT DELIVERIES of BEST QUALITY WROUGHT IRON TUBES AND FITTINGS from our LONDON WAREHOUSE and STAFFORDSHIRE WORKS.

23,000 *Items*
for GAS · WATER · STEAM · OIL · AIR ·

EB 24A

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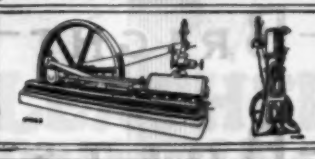
HOLLINWOOD.
STEAM ENGINES



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WRITE
LANSTON MONOTYPE CORP
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FOR ENGINEERS
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"A Plumbago Form" JOINTING MATERIAL
PERMANITE JOINTS RESIST HIGHEST PRESSURES
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EASILY REMOVED WHEN REQUIRED

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Weldless Steel Tubes for
WATER TUBE BOILERS,
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Locomotive Builders, DARLINGTON.
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LOCOMOTIVES for all Gauges and Services.
Telegrams: Rocket, Darlington; Altiscope, London
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6500 OPERATIVES.
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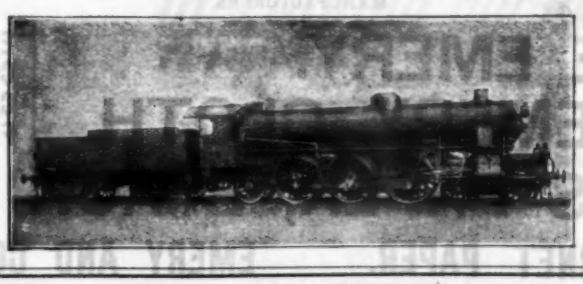
Share Capital, lt. £100,000,000



Steam and Electric Locomotives
Railway and Tramway Rolling Stock.
Portable and Thrashing Engines.
Road Rollers, &c. &c.

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OF ALL TYPES.
JOHN GRIEVE & CO.,
MOTHERWELL.

HIGH-CLASS
SAW BENCHES
Best Design and Workmanship.
Ideal Saw Guards. Safety Planer Blocks.
M. GLOVER & CO. Saw Mill and Munitions Engineers, LEEDS

BOLLING & LOWE, LTD., LONDON, E.C. 4.
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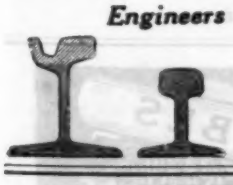
Engineers and Merchants (Formerly Wm. Bird & Co. Established 1827.)
Telegrams: BIRD, CANNON, LONDON. Telephone: City 2266, 2267.
Codes Used: A B C, A1, Engineering Telegraph, Lieber's and Western Union.



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PLANS AND ESTIMATES for Every Description of
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STOCKS OF NEW AND SLIGHTLY DEFECTIVE RAILS.

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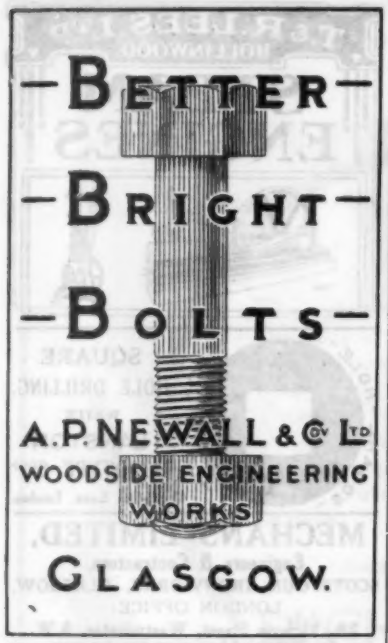
LEATHERS COMPANY LIMITED ALTRINCHAM.



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WOOLWICH, LONDON, S.E.18.
SLIP GAUGES.
Our 41 piece set gives 100,000 Standard sizes (each true to 5 parts in a million) at £16. Catalogue 3a comes on request.

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Derrick & Overhead Travelling Cranes
Worked by Hand, Power and Electric.
JOHN SMITH (Keighley), LTD.
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Pumping Machinery
for Sewage and Water Works.
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Self-Recording Instruments
for Pressure, Temperature, and Speed.

DOUGLAS FRASER & SONS, Ltd.,
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MILL GEARING, BELT PULLEYS, & ROPE PULLEYS.
See Illustrated advt. last week, page 78.

THE
MACFARLANE ENGINEERING CO.
LTD.,
NETHERLEE ROAD, CATHCART.
DYNAMOS & MOTORS.
See advertisement in issues of Dec. 19th. and Jan. 16th.

TEMPERATURE REGULATORS.
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EXPANSION STEAM TRAPS.
THE STEAM FITTINGS CO., LTD., WEST DRAYTON.
Displayed advertisement see December 12.

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SPECIALISTS IN THE DESIGN AND CONSTRUCTION
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Bridges, Wharves, Jetties, Quay Walls, Warehouses, Factory, Cold Storage and Coal Washery Buildings, Bunkers, Silos, Foundations, etc.
PRELIMINARY DESIGNS AND ESTIMATES SUPPLIED WITHOUT CHARGE OR OBLIGATION

JETTY AT PURFLEET FOR MESSRS. JURGENS, LTD.,
1175 feet long, on 390 Concrete Piles.
CHRISTIANI & NIELSEN
ENGINEERS AND CONTRACTORS.
Established 1904. *On Admiralty, War Office, and Air Ministry Lists of Contractors.*
Offices: 72-74, Victoria Street, Westminster, S.W.1.
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EMERY CLOTH.
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GLASS PAPER, BLACK LEAD.
FLINT AND CARNET PAPER.
N.B.—All Papers and Cloths are supplied in Rolls, Bands, Discs, Strips, and Sheets of almost any size and shape, to suit the special requirements of buyers. Prices quoted on receipt of particulars.
EMERY AND CORUNDUM DISCS
Of Cloth & Paper, for all Disc Grinding & Polishing Machines
EMERY WHEELS
WELLINGTON WORKS, WESTMINSTER BRIDGE ROAD, LONDON, S.E.1.

The BIRMINGHAM BATTERY & METAL Co. LTD.
SELLY OAK, BIRMINGHAM
SEAMLESS AND BRAZED
BRASS AND COPPER TUBES

BRASS AND COPPER
RODS, SHEETS, WIRE &c.
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TELEGRAMS BATTERY, SELLY OAK TELEPHONE 151 (3 LINES) SELLY OAK

Opinion of large user:- "COULD NOT REPLACE IT AS REGARDS QUALITY"

"STAUFFER'S LUBRICANT" REG TRADE MARK

FIRST IN 1882 — FOREMOST EVER SINCE

THE STANDARD MACHINE GREASE MADE SOLELY AT OUR WORKS IN LONDON FOR 40 YRS

STAUFFER'S PATENT "TELL-TALE" & "UNBREAKABLE" LUBRICATORS

TELL-TALE — FLUTED CAP — UNBREAKABLE SHANK

TRIER BROS LTD 36 VICTORIA ST LONDON SW1
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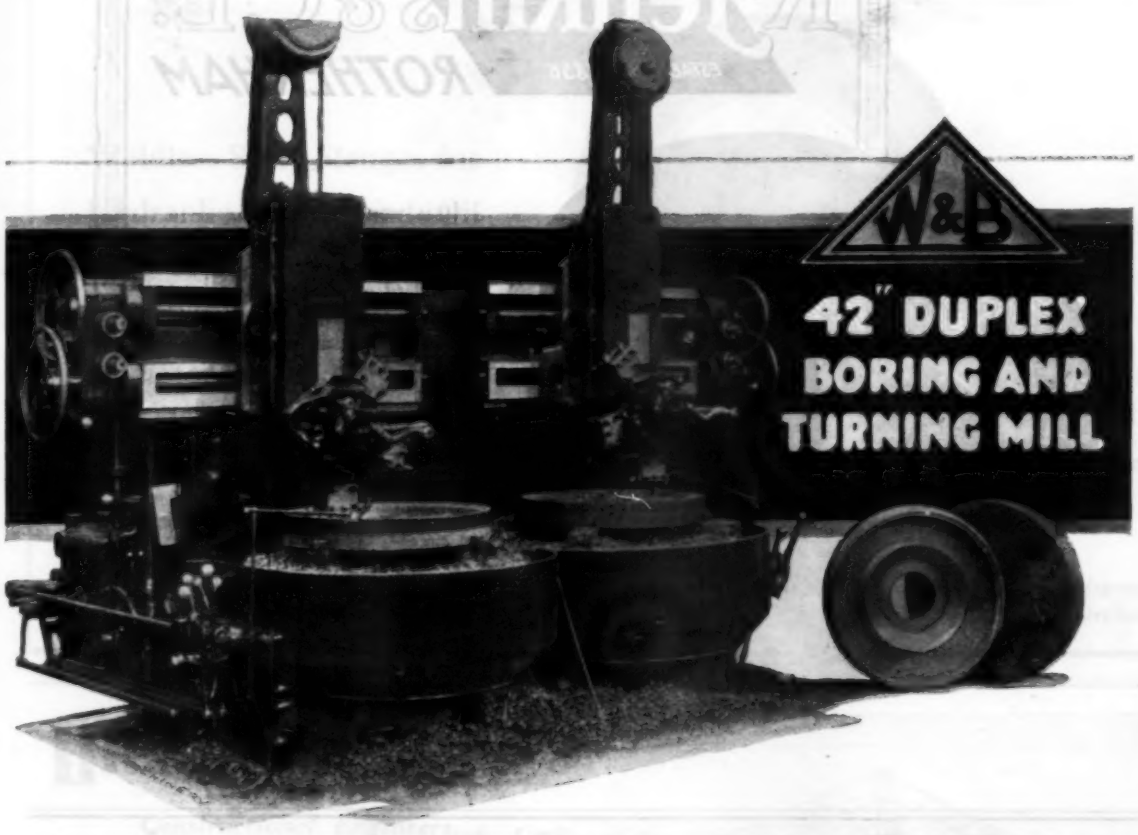
GUARANTEED GREASE TIGHT THREADS ON LUBRICATOR CAPS & SHANKS



Machining big gear blank forgings.

11 cwts. is the weight of these big gear blanks when they reach the W. & B. Duplex. This is reduced to 5 cwts. after all the turning, facing and boring operations have been performed. Finished dia. is 28¼" by 4¾" wide.

The metal is 42 tons tensile steel, but the usual high output rates for these machines are well maintained and the turning, for instance, is done at 60' per minute, with a ½" cut, 1/16" feed.

This heavy cutting is ordinary performance on W. & B. Duplex Mills. It testifies to substantial construction and correct design. Also, in combination with the fact that both tables are operating simultaneously and independently, and that only one operator is required, it accounts for the exceptionally low production costs possible on these machines.

We build a range of sizes, to swing from 18" to 60", and we invite you to let us prepare figures as to the output capabilities of our machines on your own work. Write us to-day.

WEBSTER & BENNETT, LTD.,
Northey Road Works, Foleshill, Coventry.
London Address: 32, Victoria Street, S.W.1.

LEATHER BELTING

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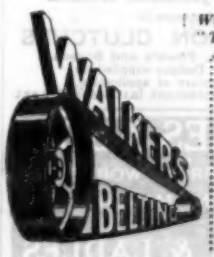

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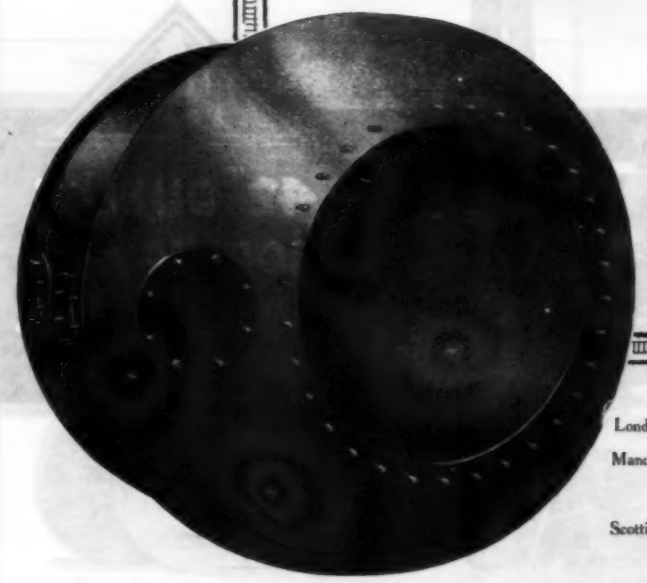

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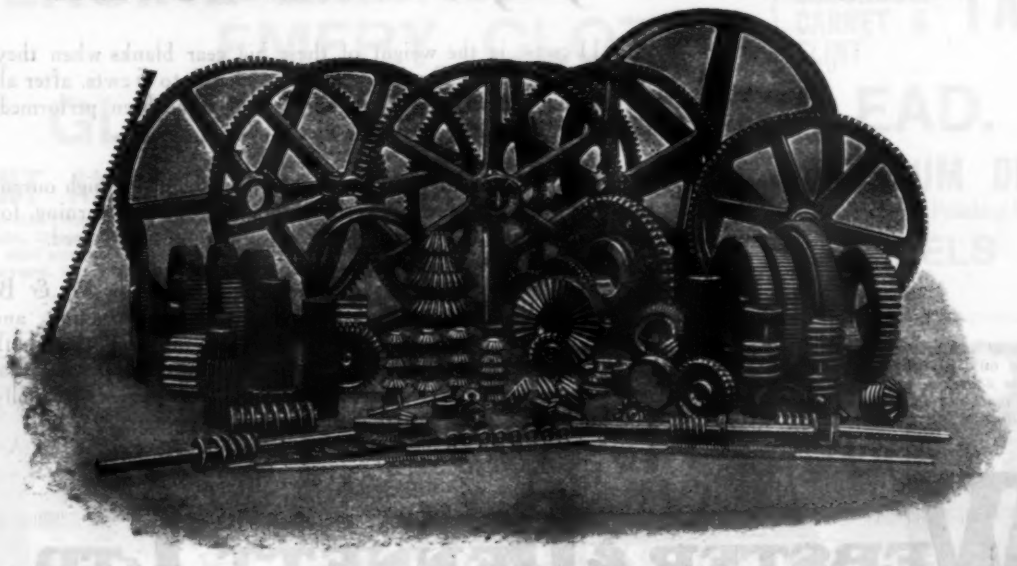

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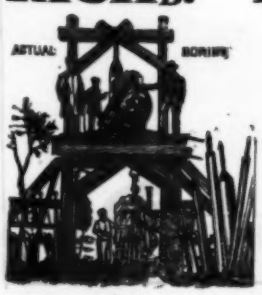

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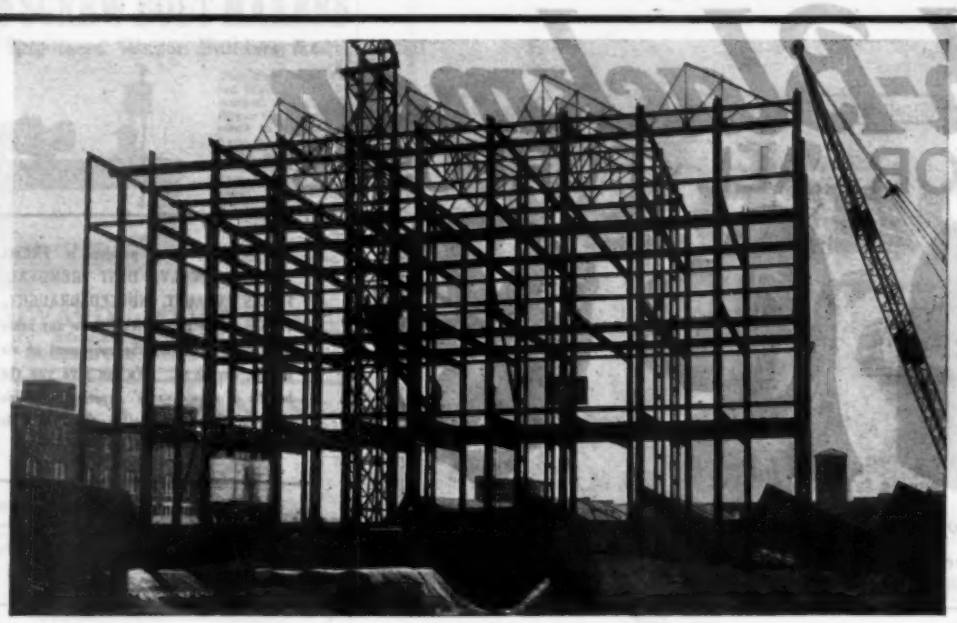

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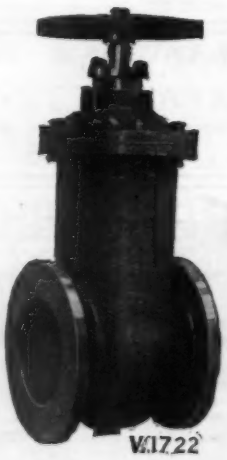

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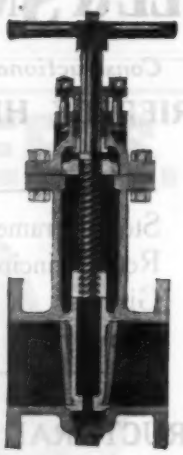

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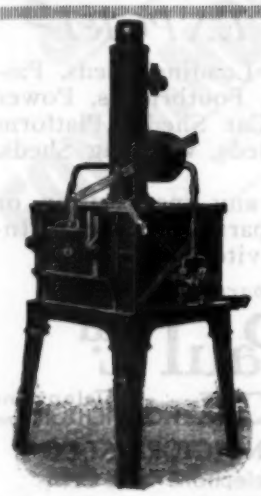

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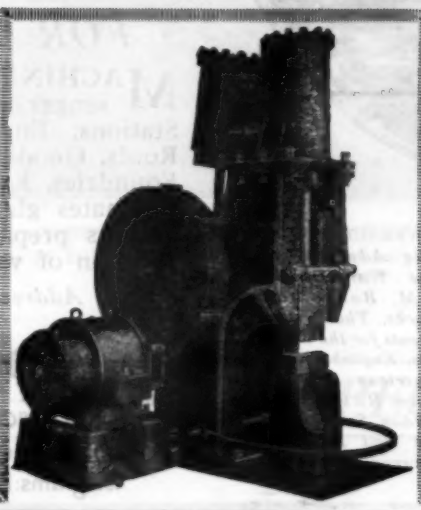

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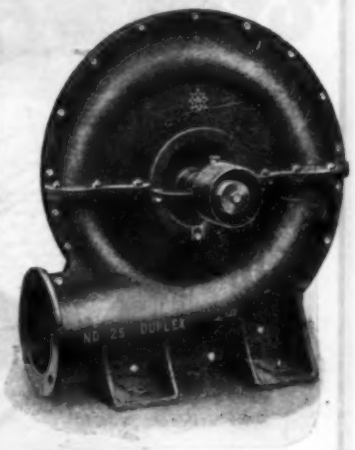

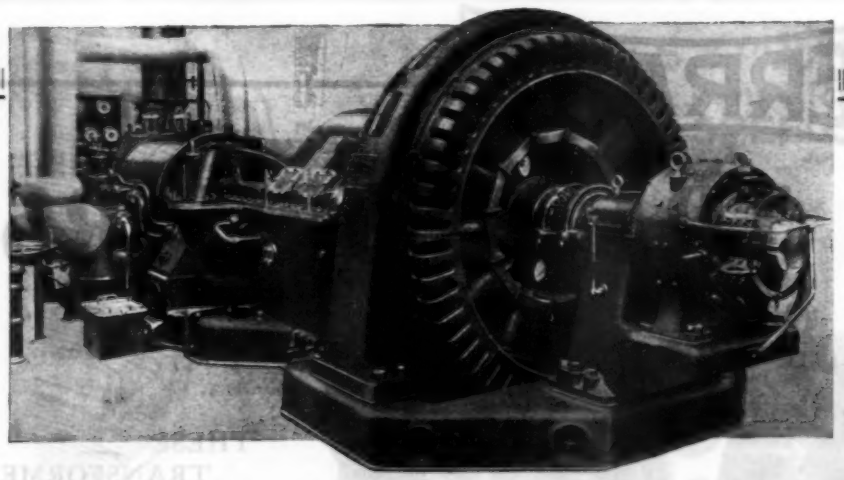

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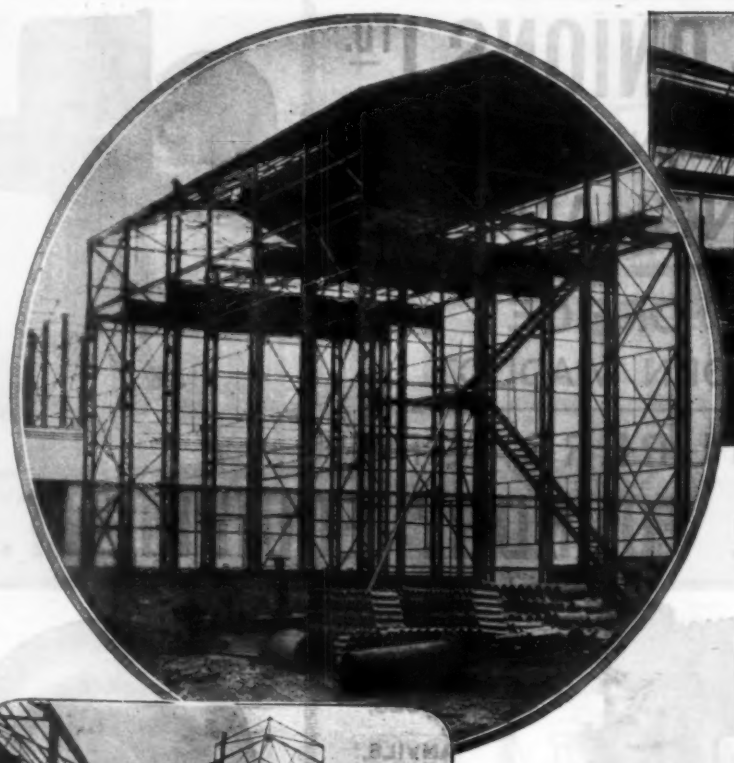

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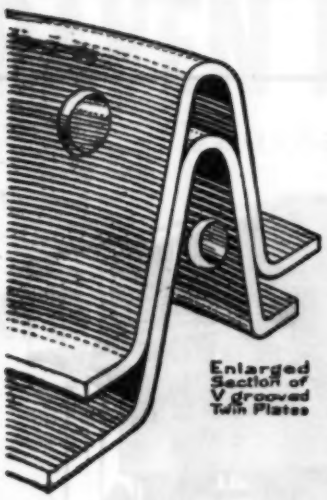

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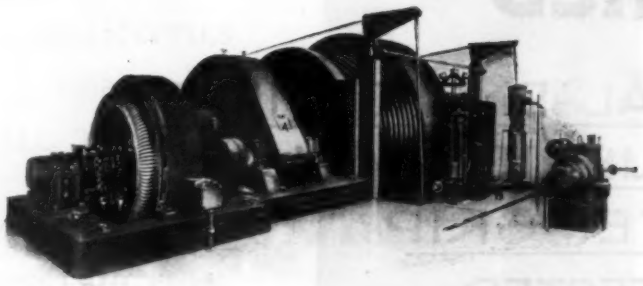

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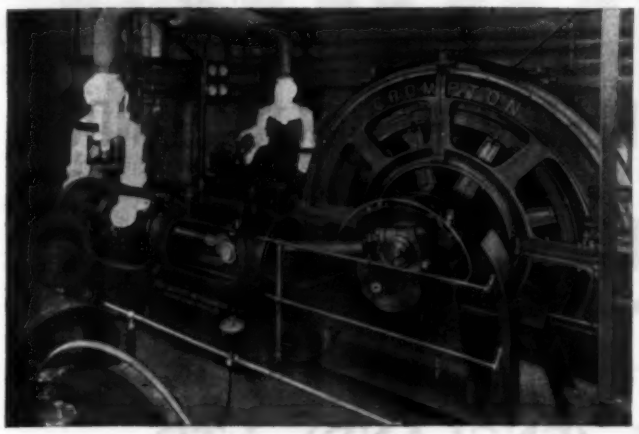

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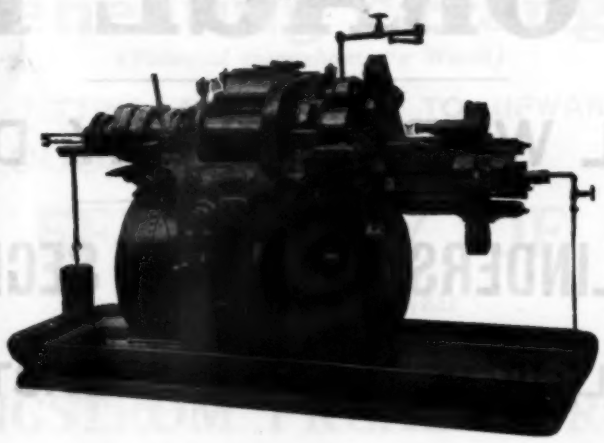

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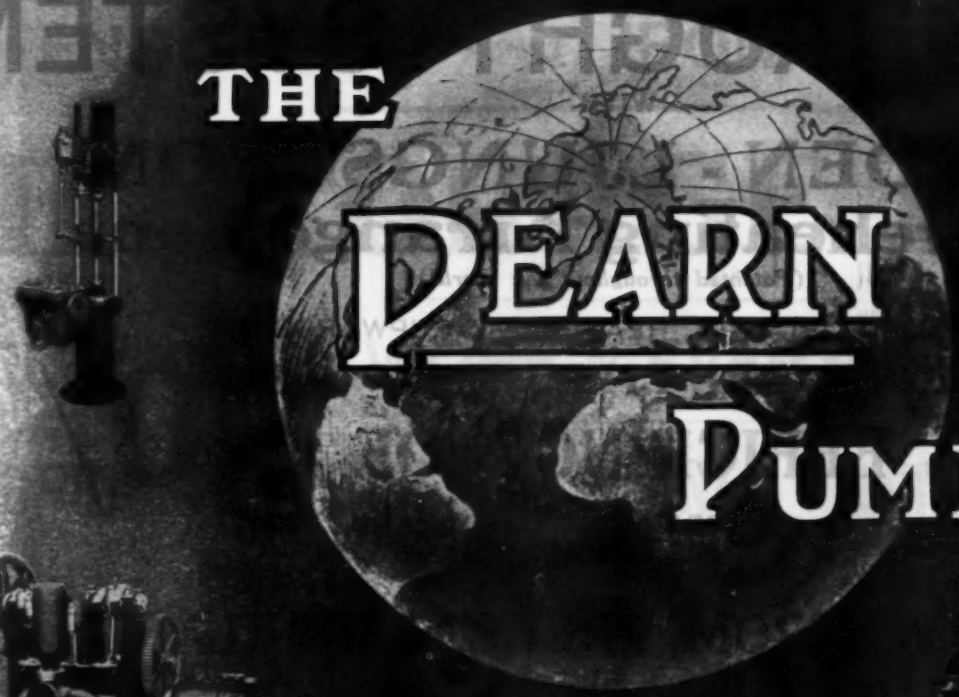

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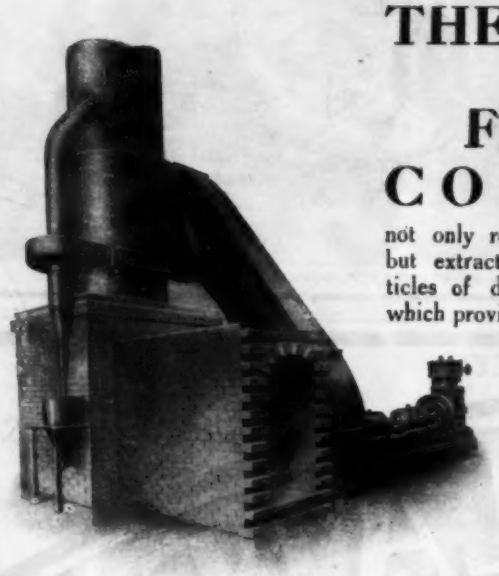

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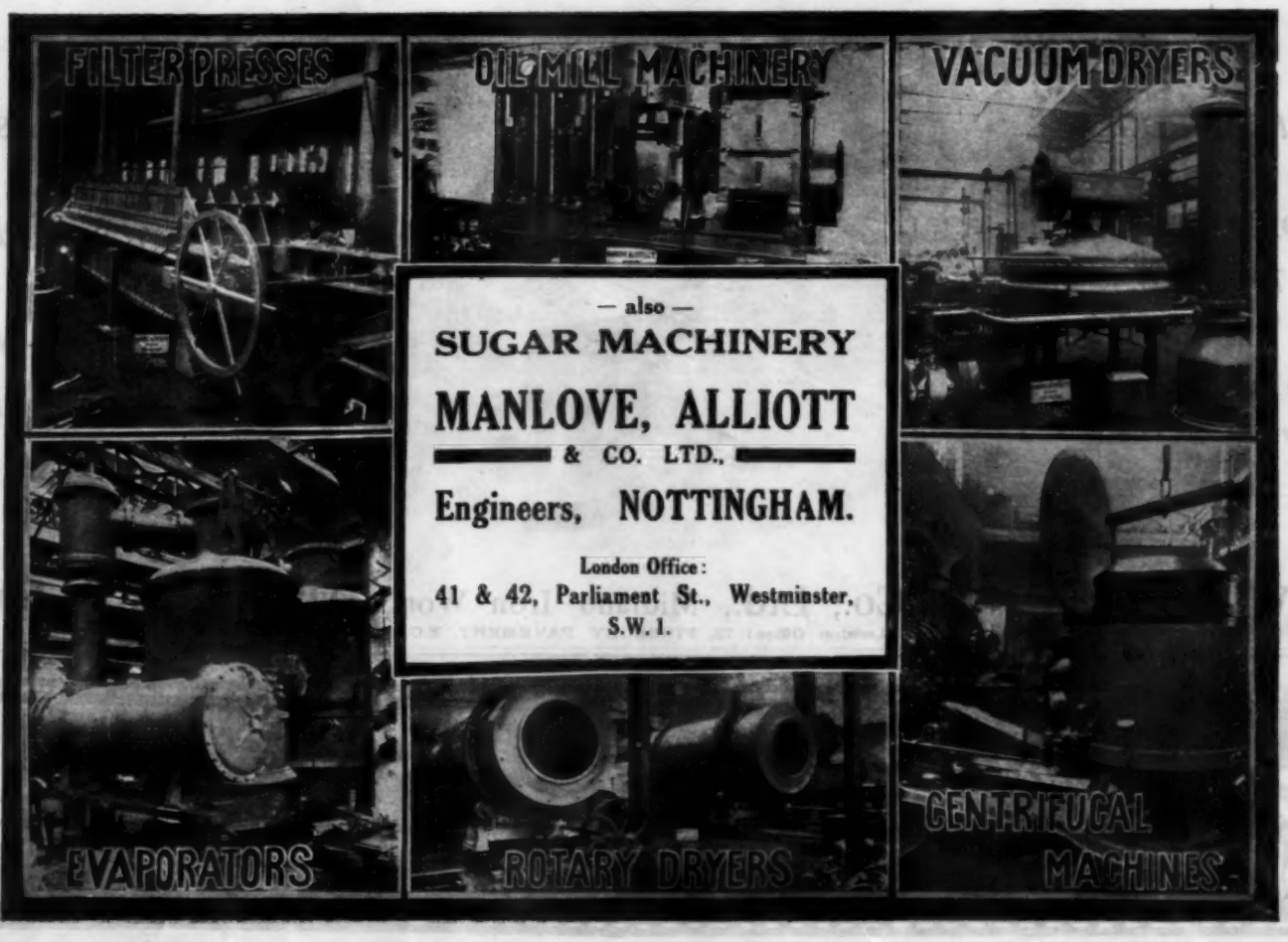

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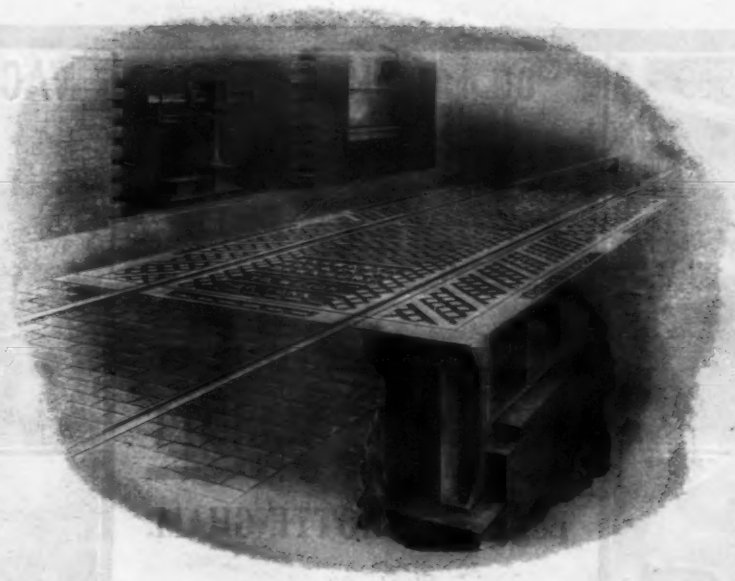

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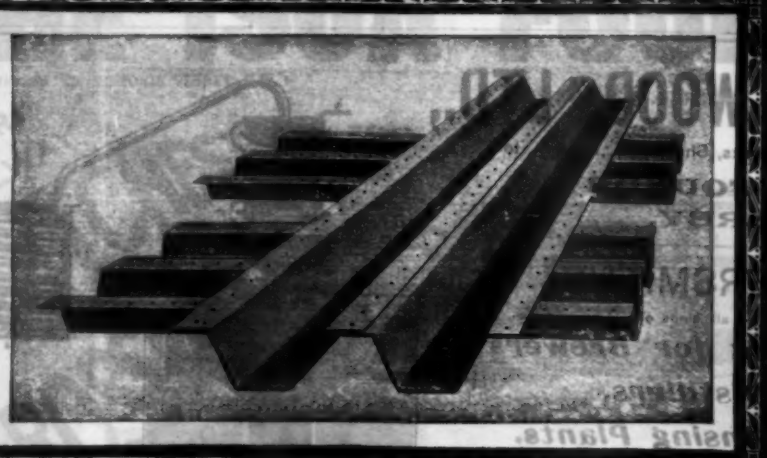

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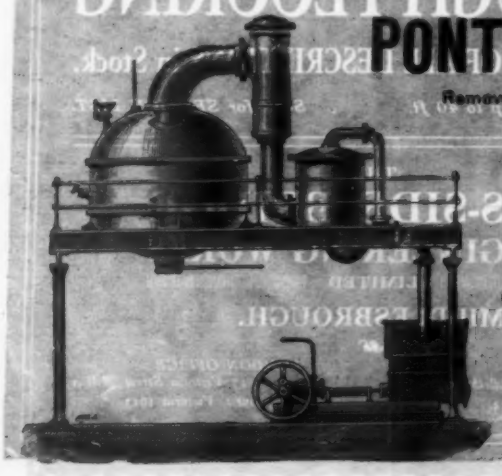

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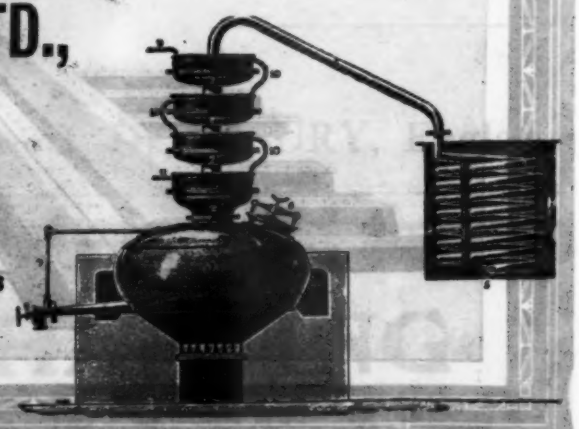

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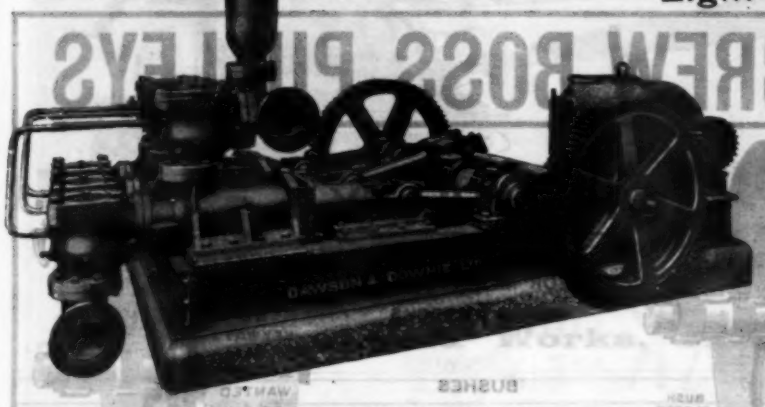

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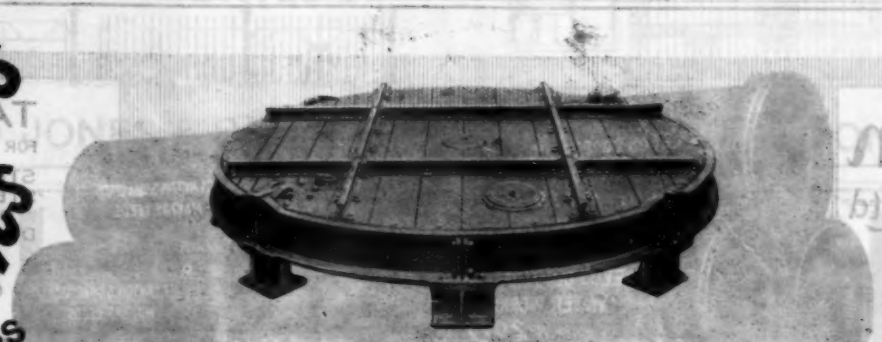

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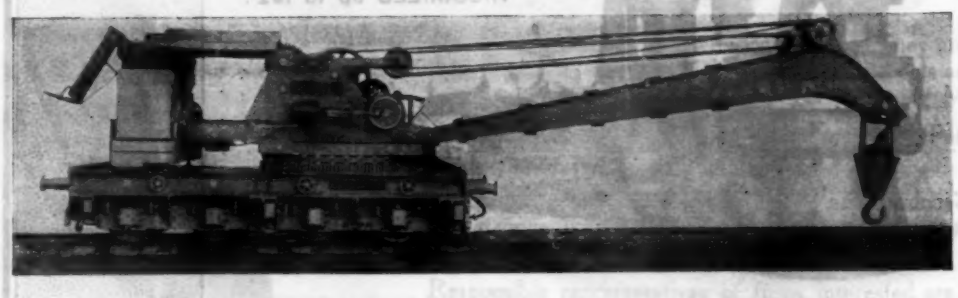

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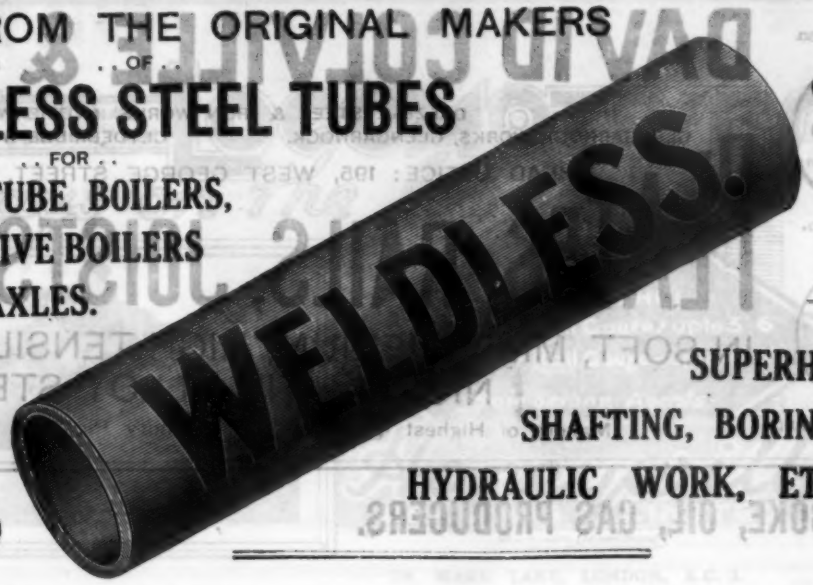

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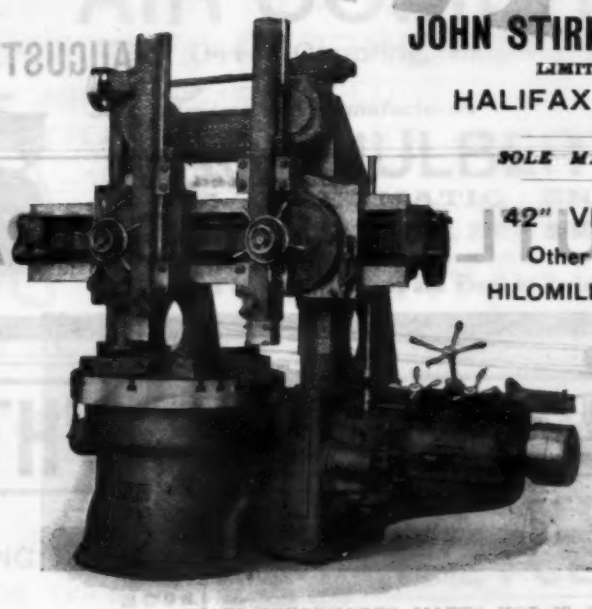

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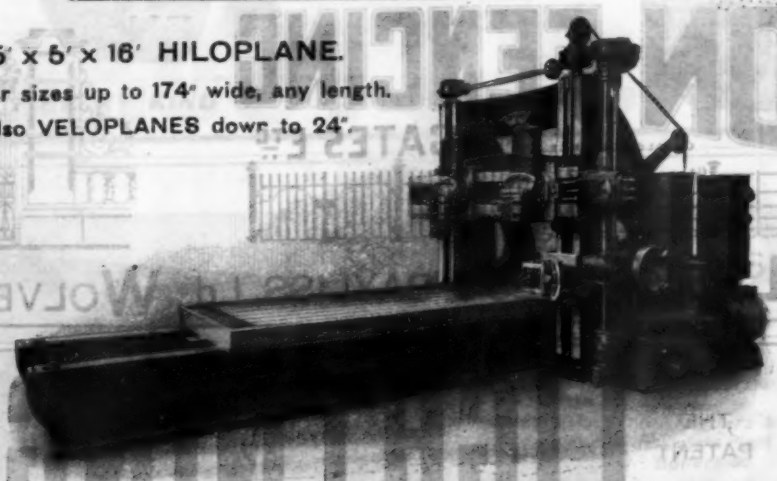

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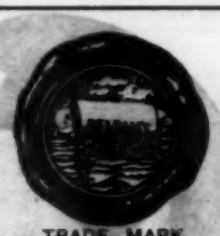

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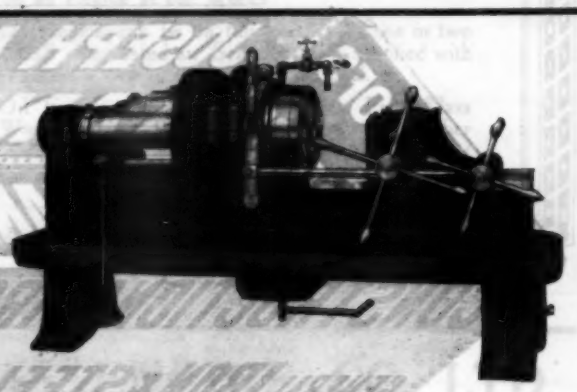

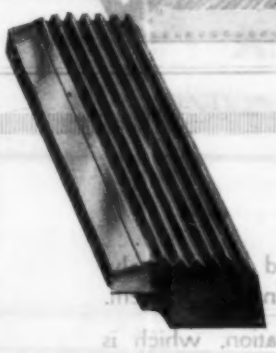

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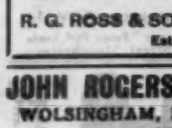
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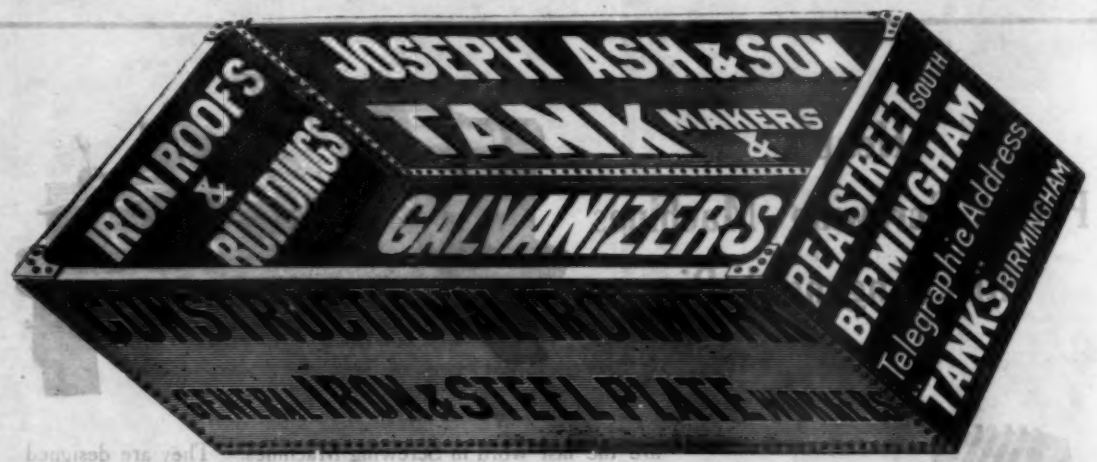

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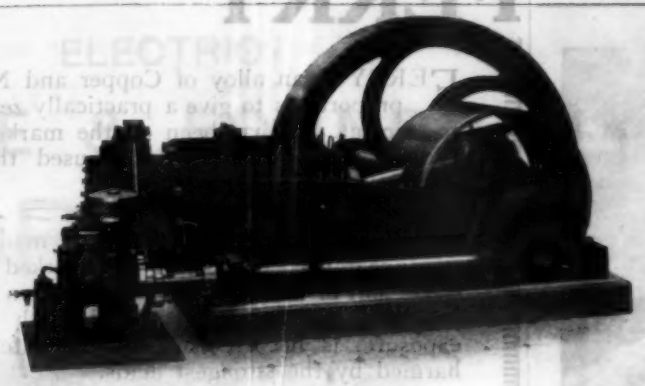

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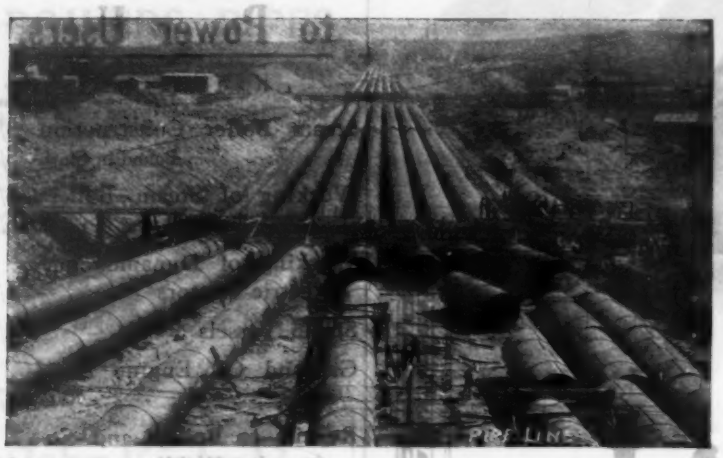

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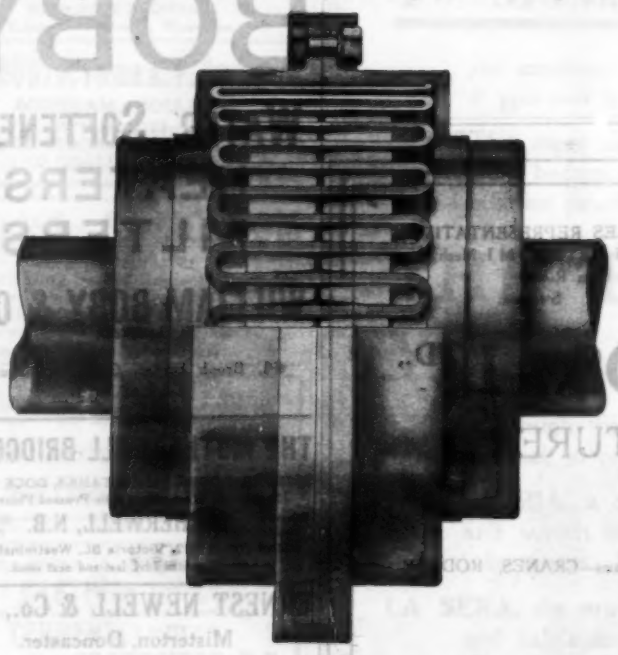

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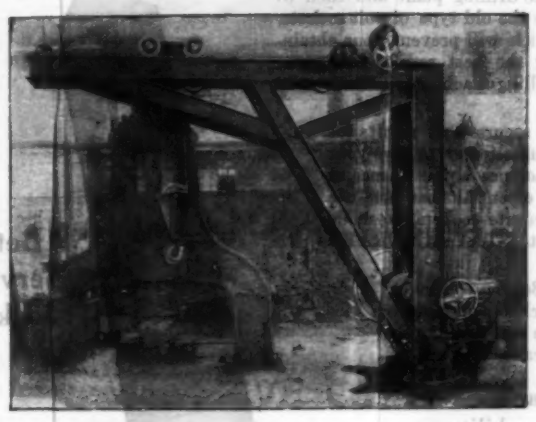

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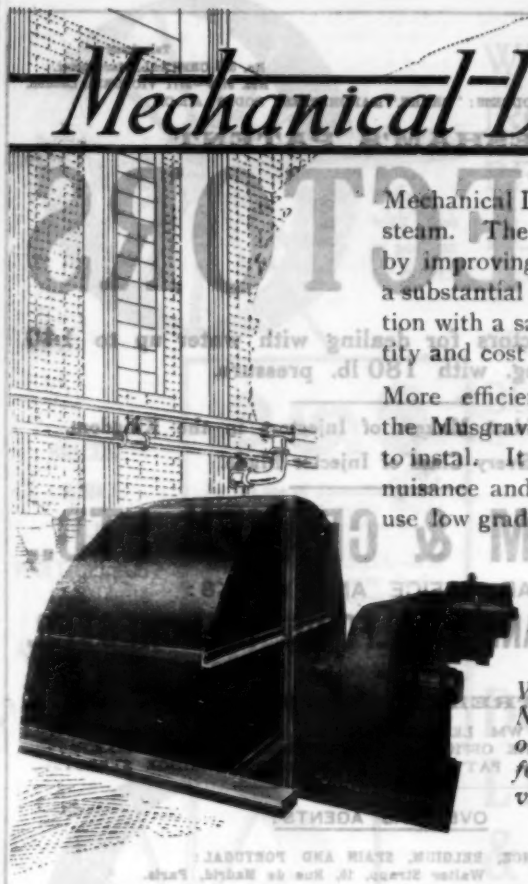

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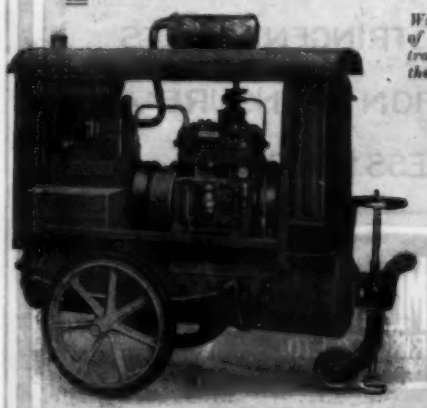

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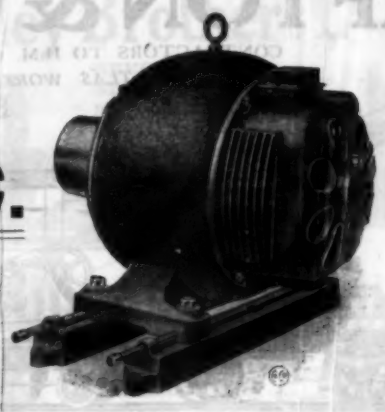

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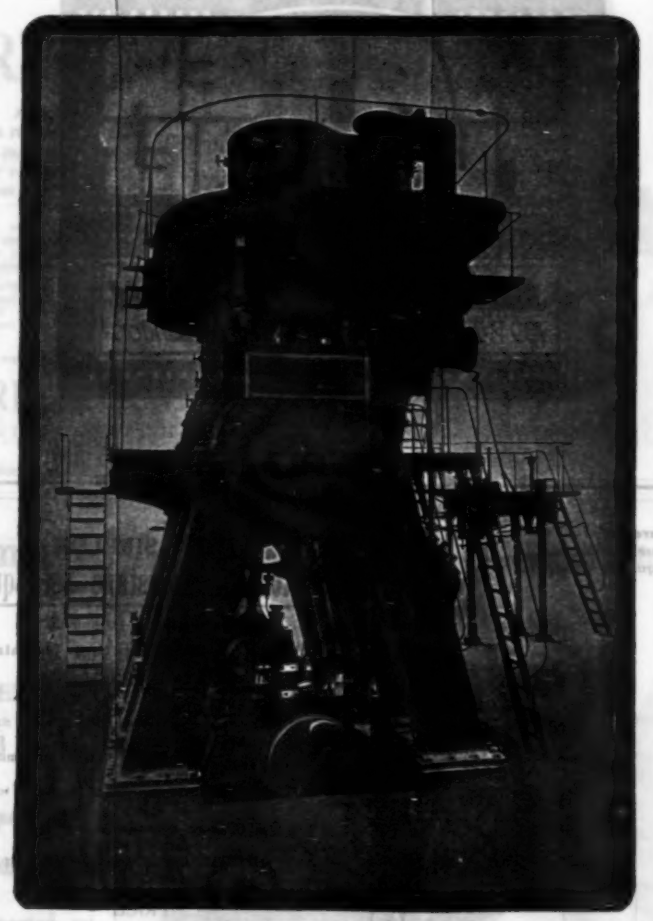

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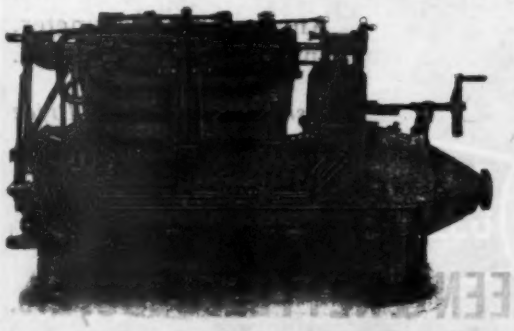

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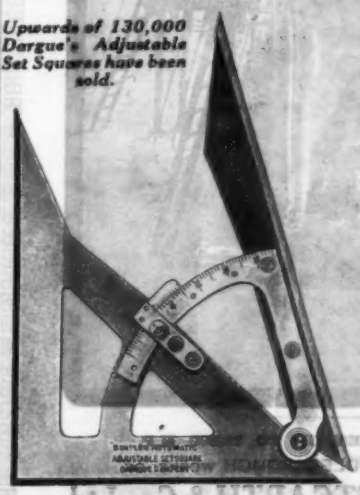

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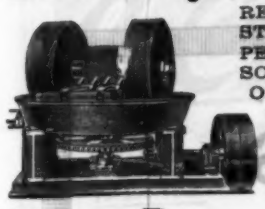

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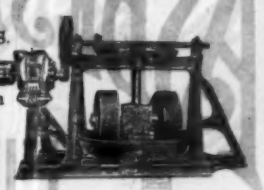

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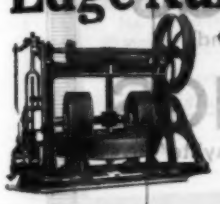

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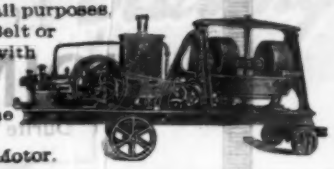

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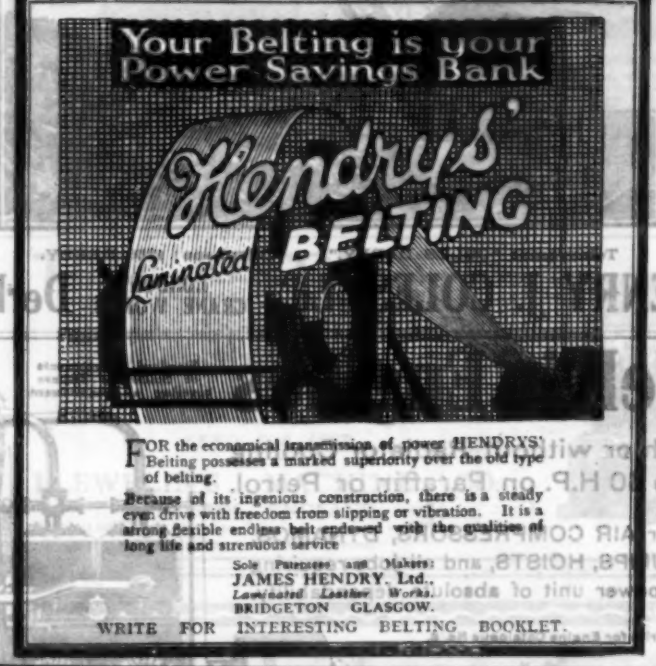

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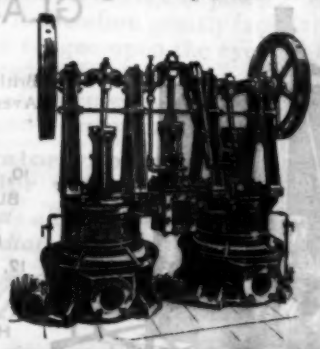

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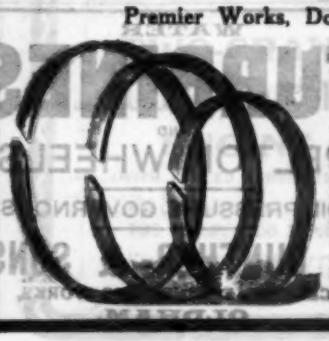

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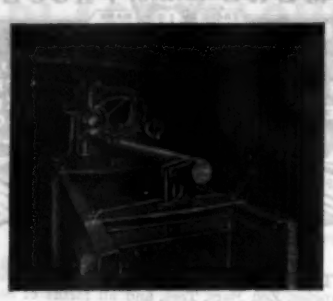

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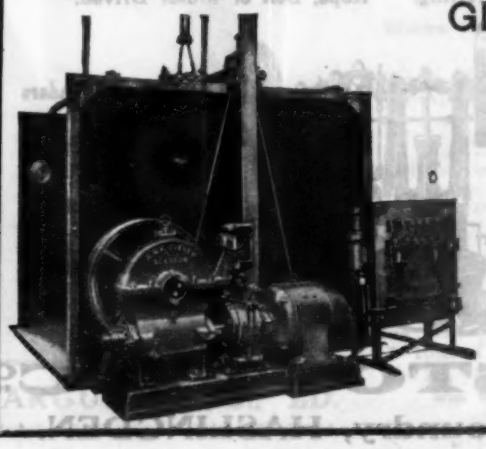

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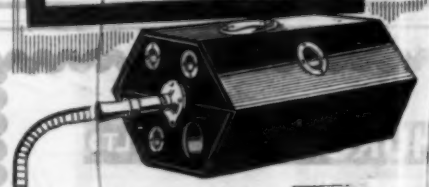

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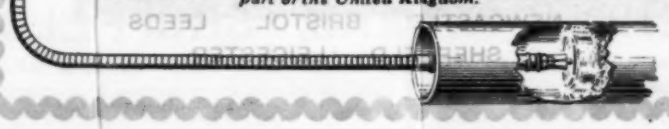

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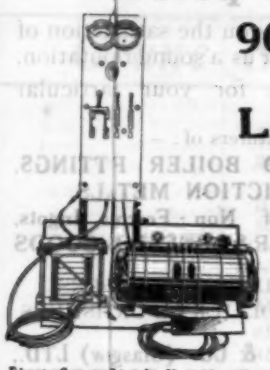

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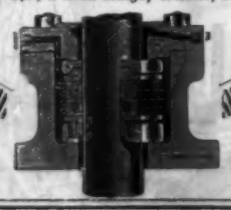

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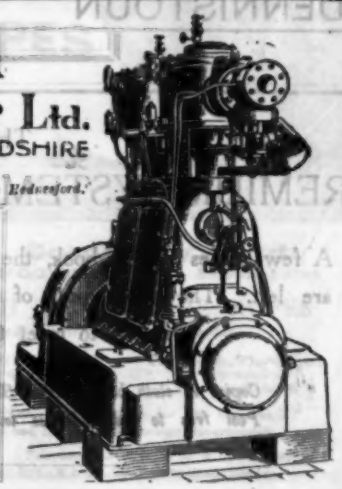

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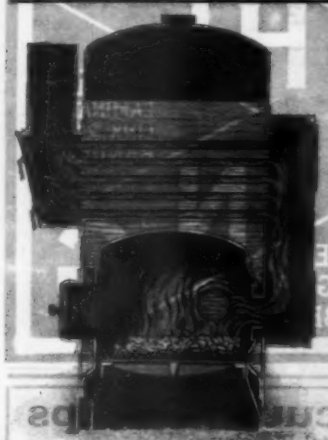

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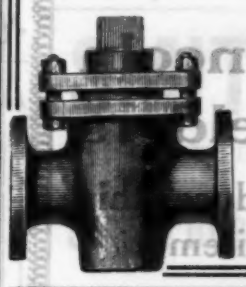

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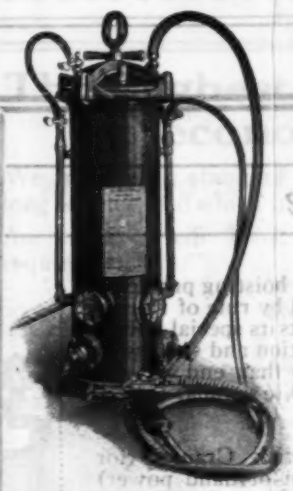

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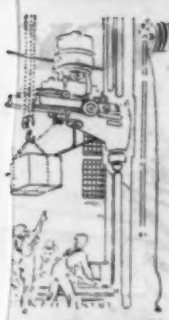

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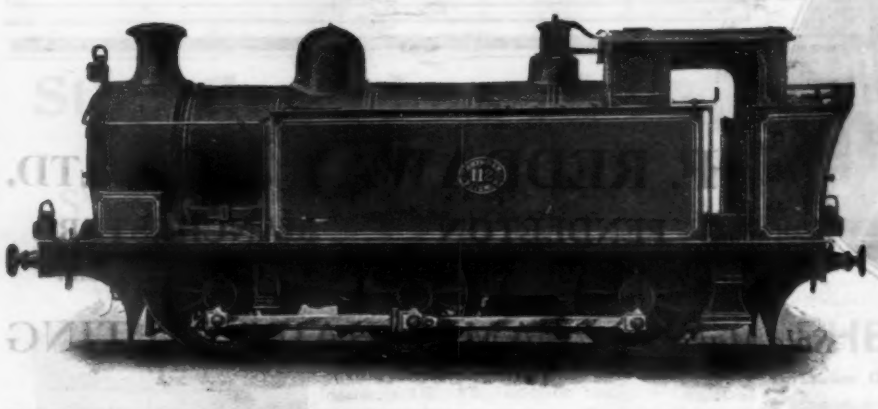

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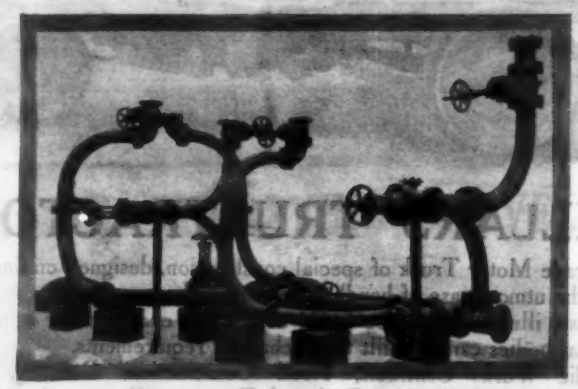

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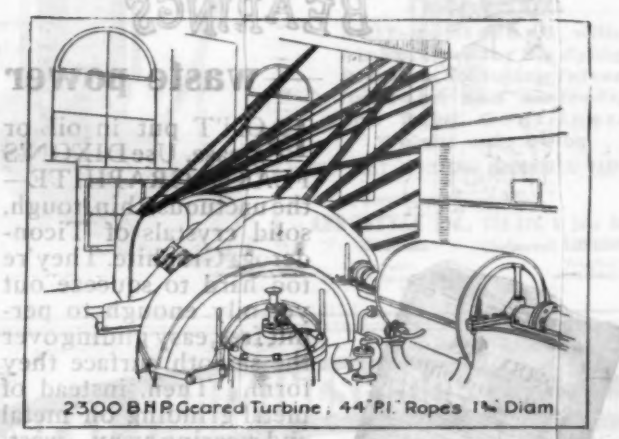

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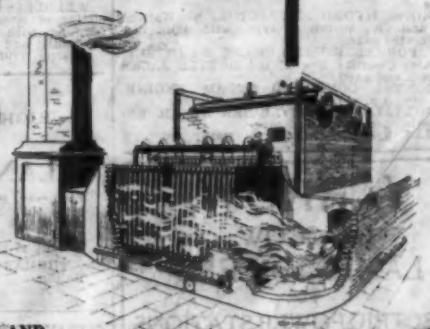

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Continued from page 2.

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Three Electric Capstans, by Ransomes and Rapier each to haul about 40 tons on straight level track, and self contained with 6.75 B.H.P. Motor, 210 volts D.C., foot control.

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Two Babcock and Wilcox Water-tube Boilers, each 9000 lb. per hour, 165 lb. pressure, new 1917, chain-grate stokers and superheaters, splendid condition.

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